CPM SCHEDULING: THE CONTRACTING OFFICERS' GUIDE FOR RISK MINIMIZATION AND CLAIMS ANALYSIS

by

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dedicated with the deepest love and affection to
my wife, Susan
and my children, Craig Jr. and Khaila.

their love, wisdom, strength, and encouragement
have inspired me to be the
best I can be.

I would like to acknowledge my previous boss; CAPT Charlie Fehlig, the Officer in Charge of Construction at Portsmouth Medical Center, Portsmouth Virginia for having faith in me by appointing me as the CPM Schedule Engineer for the $160M Acute Care Facility Project. His patience and encouragement were invaluable to my growth.

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CHAPTER I

INTRODUCTION

1.1 Abstract

There are several hundred contract management related positions in the Navy's Civil Engineer Corps. Many junior and senior Contracting Officers and their representatives who serve in these positions have little to no experience with approving, monitoring and analyzing contractors' construction schedules. Typically, the contractor submits an initial schedule for approval, however, due to the lack of experience and knowledge, scheduling software and computer hardware to verify schedule logic, relationships, activity content, and budgeted cost allocation, many construction schedules are approved based on their graphical appearance and the faith in the contractor to do the right thing. As required by project specifications, monthly update schedules are normally provided by the contractor, however, many of them either are updated incorrectly or don't accurately reflect the actual work sequence of the project.

The current Naval Facilities Engineering Command (NAVFAC) guide specification provides basic guidance, however, it has proven to be an ineffective tool because of unclear and ambiguous directions and guidance. Further, many sections of this specification are obsolete or contradictory to industry standards and court rulings. Claims court journals are filled with case law examples involving suits against the Navy for schedule related issues. The American Arbitration Association has handled

many arbitration and mediation cases involving these issues as well. The energy, effort, and intent demonstrated by Contracting Officers and their representatives have been sincere and noteworthy. However, their limited experience and knowledge with approving, monitoring, and analyzing construction schedules and lack of resources immediately available, have increased their risks and reduced their ability to effectively justify and defend their positions during litigation, arbitration or mediation. Even with the best scheduling specifications and supervision efforts and performance on behalf of the Contracting Officer, construction projects are still susceptible to disputes involving schedule related issues for other reasons.

Thus, the principal objective of this master report is to provide Contracting Officers and their representatives with a comprehensive guide to assist them with approving, monitoring, and analyzing the contractors construction schedules so that their risks of claims involving schedule related issues are minimized. However, to handle those inevitable claims, this guide also provides several schedule analysis techniques, including their strengths and weaknesses, to assist the Contracting Officer in the claims analysis process. Further, in consistence with the phrase, "a great offense should have a great defense", several defenses to attack the techniques used by many contractors are also provided.

1.2 Scheduling Background

For all of recorded history, man has found it beneficial to schedule and plan his daily activities. This has permitted him to organize his days to achieve the optimum use of time. This necessity was carried over into man's places of business as well. Construction scheduling is not a new phenomenon since man has been planning complicated projects for many centuries. The concept of having someone plan out materials, labor, equipment and tools to do tasks with some degree of sequencing has been around since the beginning of man's existence. The modern art of scheduling began with the development of the Bar chart, often called a Gantt chart, approximately 80 years ago. The bar chart was originally applied to industrial management but was later adopted by the construction industry. However, not until the development of network diagramming techniques, which have the ability to illustrate activity logic and budget relationships, did scheduling construction projects receive serious attention. The construction schedule is a time-phased plan to perform the work that is necessary to complete a construction project. The increased use of network scheduling as a planning and control tool for construction projects has caused legal definitions of the participant's rights, responsibilities, and liabilities.

Construction schedules are not sacred. There are great and poor schedules. Great schedules can mean successful projects, but they don't offer any guarantee. Despite great schedules, projects can still go poorly because of misinterpretation, indifference, interference, arrogance, or ineptitude.

CHAPTER II

PROJECT SCHEDULING TECHNIQUES

2.1 Project Scheduling

The project schedule serves several functions and have different meaning to contractors, subcontractors, owners, architects, engineers, users, lawyers and judges. The numerous diversified meanings and functions are too plenty to include in this master report. However, despite this seemingly wide variety of functions and meanings, there are only a few types of formal construction schedules. Several scheduling techniques exist in the construction industry, however, the most commonly encountered are Bar (Gantt) charts and Network-based Critical Path Method (CPM) schedules.

Regardless of the type though, schedules are designed to establish the sequential order in which construction is to be completed. To accomplish this, an intimate knowledge of construction methods combined with an ability to visualize discrete work elements and effectively involve all key parties of the construction team are essential. Which schedule type to use should be evaluated with respect to its suitability for documenting the characteristics of the planned project, the knowledge and level of sophistication of those who are expected to use it, the desired level of detail, and the means available for updating and revisions (2:253).

From the Contracting Officers perspective, schedules provide an early indication of when the contractor plans to complete the project and indication of what the contractor believes will be the critical path of the project. In turn, the Contracting Officer can help ensure that the activities they are responsible for are kept on schedule. Further, the Contracting Officer can react to the contractor's schedule and problems more effectively by being aware of the current posture of the project and the critical areas thereof. Through the update process, the Contracting Officer is constantly advised of the status of the project, schedule trends, schedule criticality and can re-evaluate its plan accordingly.

From the contractor's perspective, schedules not only satisfy the contractor's contractual obligation to schedule and coordinate the project, but provides him the opportunity to discuss, in detail, the various subcontractors' and suppliers' plans for performance and the compatibility of those plans within the overall project objectives. It provides a dynamic tool with which to monitor progress of the project and all the parties thereto while advising all parties of their relative importance of their timely performance and whether their work is critical or has ample float time. Further, effective schedules, and those projects completed on schedule, provide a track record of on-time performance, which is one of the single most important factors in the evaluation process for future work. Schedules also permit all parties to more accurately evaluate the impact of delays on the construction project (9:411-413).

2.2 Bar (Gantt) Charts

The Bar chart schedule was developed by Henry Gantt in the early part of the century. As illustrated in Appendix A, a typical bar chart graphically describes a project consisting of a well-defined collection of tasks or activities, the completion of which marks its end. A bar for each activity reflects start and end dates. They are linear diagrams with a horizontal axis showing project time and a vertical axis listing work phases and activities. Projects are managed and controlled by marking off the work completed and by observing the amount of progress as compared to the original schedule.

Bar charts simple graphical form results in relatively easy general comprehension. This has led to their common acceptance and widespread use as a good form of communication in construction, with a basic understanding usually found at all levels of management. Since they are fairly broad planning and scheduling tools, they require less revision and updating than other types of scheduling techniques. However, bar charts have several fundamental weaknesses. Most damaging, is its inability to illustrate logical interdependencies amongst activities. Therefore, it is very difficult for someone to reconstruct the logic and to recognize sequence constraints. Additionally, bar charts are difficult to use for forecasting the effects of changes in a particular activity will have on the overall schedule, or even to project the progress of an individual activity. They also can become very cumbersome as the number of activities increases (2:258). Bar charts can be valuable assets for some small projects, however, their limitations makes them less effective and appropriate in larger project applications.

2.3 Critical Path Method (CPM)

Graphical network-based scheduling diagrams, particularly CPM schedules, used for schedule, resource, and cost analysis have proven to be the most powerful analytical tool for project planning, control and claims analysis. They evolved from a research effort initiated in late 1956 by the E. I. Du Pont de Nemours Company. Appendix B illustrates a typical CPM activity-on-node (AON) Time Scaled Logic Diagram schedule. The CPM schedule is based on the establishment of logical relationships between activities, explicitly and implicitly. The network is only as good as the contractor's plan and ability to effectively involve all key players, including subcontractors, suppliers, owners, architects, engineers, and users in its development and maintenance processes. Logic should be developed with safety, space and structure in mind. Each activity should contain detail identification data such as activity durations, budget data, constraint data, and time data to distinguish itself from another activity. The necessary activity information will be discussed in more detail in chapter 3.3.

Since network-based scheduling techniques graphically illustrate the logical interrelationships and dependencies among activities, they are more useful for forecasting and controlling projects than Bar charts. CPM Networks also encourage a higher level of logical discipline in the planning, scheduling, and control functions, and stimulate more attention to both long-range and detailed planning. They usually make personnel think about a project in more than usual detail and tends to prevent omission of important actions in the project plan. A CPM schedule simplifies advance work assignments and helps improve communications among those responsible for the project. They also immediately identify the most critical activities in the project schedule and thus allow management to set priorities and focus on them. A CPM schedule can insure continuity of action even with changes in personnel and provides a measure of performance. It measures proposed changes against time, money, manpower, and equipment demands and limitations. However, given all this detail, the network-based schedule requires more time, effort, and money to develop. Further, they are more difficult to comprehend than the Bar chart technique (2:268).

The CPM has proven to be an effective tool for planning and scheduling work, directing work, and measuring and controlling work. It permits the work schedule to be understood and thought out well in advance for material procurement, equipment availability, and resource assignment. Preparing the CPM diagram encourages complete project planning from start to finish, hence, permitting early identification of potential problem areas on the project. The CPM diagram also illustrates whether the scheduler has a good understanding and familiarization with the project and construction process. The CPM is used in three major phases on a construction project; planning, scheduling, and controlling. The planning phase involves developing an initial plan of action for the best approach based on many alternatives. During this phase, work activities and their relationships are defined. The scheduling phase involves defining activity durations, activity resource allocation, and any scheduling constraints or challenges. The controlling phase involves the decision making process based on actual performance, alternatives, trends, material supply, change orders, and changed conditions.

Since the CPM technique is more widely used and offers greater project planning and control advantages, this report will focus primarily on CPM construction schedules. However, the discussions in this report may be applied to other network models as well.

CHAPTER III

DEVELOPING A CPM SCHEDULE

3.1 CPM Scheduling Fundamentals

Assembling the CPM construction schedule can be an extremely intricate task since construction projects may involve hundreds to thousands of activities and relationships. The CPM schedule developed will only be as good as the specifications provided, time invested, relationship between the contractor and their subcontractors and suppliers, and the experience and knowledge of the scheduler. A schedule with unrealistic activity durations or faulty logic will be of limited use to all parties involved. Construction scheduling requires foresight, experience, and open communications. Once a project is accepted, the scheduler must develop activities and placed them in the proper logic sequence in order to complete the project. Once the logic is determined, a duration for each activity is determined based upon available resources and constraints. Activities should be assigned several filter codes to permit effective and informative sorting in various categories throughout the life of the project.

A good schedule usually exists between the limits of having every activity starting by the early and late start times. Activities starting at or near the early start times result in a very high expenditure rate at the beginning of the project. This creates a CPM schedule with more float, hence, a less time sensitive project completion date. This approach requires the contractor to finance more of the project costs early, hence, tying up capital and resources from other projects. From the Contracting Officer's perspective, there is more time to incorporate additional changes without suffering increase cost and effecting the project completion date. Employing the latest start times results in less float and more critical activities, hence, a more time sensitive project completion date. Now any change or interruption may increase costs and cause delays to the project completion date. The cost increase associated with a change may have a higher overhead cost than normal because some capital may be sitting idle while the change is being worked on. Even though employing these methods are common, they are not effective with managing and controlling resources. The extreme rises and falls in resource usage caused by these methods increases costs, and limits management's ability to effectively coordinate and schedule work activities. The best scheduling method is one that minimizes the fluctuations in resources and provide flexibility in the schedule to meet unexpected conditions. This requires the schedule to be cost and resource loaded and resource leveled (1:23-25).

3.2 Party Responsibilities

The contractor is responsible for developing a progress chart pursuant to the clause entitled "FAR 52.236-15, Schedules for Construction Contracts" of the Contract Clauses (8:1). However, in order to obtain a CPM (Precedence Diagramming Method) schedule, the project specification should specifically state so. If the specifications do not clearly detail the specific type of diagram and network planning technique desired, the contractor is contractually authorized to provide the bear minimum schedule to show initial plan and progress. This may be as simple as a basic bar chart. Thus, the specification should require the contractor to be responsible to develop the CPM construction schedule, create the network, produce the necessary reports, execute the plan as described by the CPM network, actively participate in CPM meetings with the Contracting Officer and other key personnel, and submit progress and revision data as delineated in the contract documents.

The contractor should be required to develop the CPM schedule that represents the game plan for the project for all to see and it should serve as a baseline from which to evaluate project problems and delays. It should include all the work elements required for the performance of the contract. Any required work elements not included in the CPM schedule shall not excuse the contractor from completing all work for performance. He shall distribute the CPM schedule to his subcontractors and suppliers for their review and comments. Throughout the duration of the project, the contractor should be required to maintain the continual involvement of the major subcontractors in the scheduling process. Each subcontractor shall provide written approval and/ or concurrence with the CPM schedule and provide a copy to the Contracting Officer. If a particular subcontractor has not been awarded for a certain portion of the work, at the appropriate time, the contractor shall modify the CPM data to reflect any changes resulting from this new contractual agreement (8:1-2).

The Contracting Officer is responsible for reviewing the contractor's CPM schedule. Most project specifications also places the responsibility for approving the CPM schedule on the Contracting Officer as well. A significant amount of literature and court and board cases support both, approving or reviewing the contractor's CPM schedule. There are several documented advantages and disadvantages for both actions. Approving the schedule may imply that the Contracting Officer warrants the schedule. This increases the Contracting Officer's risks because it identifies a compliance with the schedule's accuracy, contractor's plan for sequence of work, budget assignment, resource allocation, activity duration, logic, sorting abilities and time for completion. The decision by the Board of Contract Appeals in *Sante Fe, Inc. v. United States* identified that an owner may be responsible for the time for completion in a CPM schedule when the owner approves the schedule (9:469-470). These risks are greater because the Contracting Officer is completely unaware of the intricacies and "politics" involved with subcontractor and supplier scheduling and coordination. As importantly, during the approval process, the Contracting Officer does not have enough time or resources to effectively and efficiently evaluate the CPM schedule to completely understand all the relationships and logic of the project. Overall approval authority also provides the Contracting Officer the contractual right to express objections and direct revisions to the contractor's CPM schedule. This can cause even greater dilemmas because the contractor can later claim that these revisions by the Contracting Officer caused delay and claim conditions. Therefore, a CPM schedule approved by the Contracting Officer, may be difficult to refute at a later date during the claims process.

To avoid assuming these risks, the specifications can limit the Contracting Officer to only acknowledging receipt of the schedule and providing comments, as deemed necessary. In this case, the Contracting Officer should conduct the most thorough, fair, honest, yet firm review as possible, even if it requires hiring a CPM consultant. During this phase, it is extremely critical that the Contracting Officer provides comments on all inconsistencies, discrepancies, and problem areas in the CPM schedule. Silence by the Contracting Officer may well be interpreted as assent to the content of the schedule (9:487). However, the lack of approval authority for the schedule will deprive the Contracting Officer the right to reject unreasonable plans for performance and force the contractor to incorporate specific comments and revisions. It also exposes the Contracting Officer to potential claims for early completion and denies both parties a baseline from which to evaluate project problems and delays. Lack of approval of the contractor's CPM schedule though, still does not release the Contracting Officer from his obligation to perform within the time required by the schedule. If the CPM schedule indicates a 30 day duration for submittal review and this is outlined in the specifications, then the Contracting Officer is obligated to adhere to the CPM schedule. This is supported by the decision of the Board of Contract Appeals in *Carney General Constructors, Inc. v United States* which found that although the owner had not approved the CPM schedule, the owner was liable for the cost of delays. In this case, the schedule revealed a reasonable time and duration for the delivery of owner-furnished equipment. Since the owner delayed the schedule by more than 3 months, he was liable for the 3 month delay.

Based on the majority of the referenced literature and my experience, approval authority should be granted on a case by case basis. Approval authority should be granted only to trained contracting staff with the necessary resources including a scheduling analysis and logic tracking programs such as Claimdigger. They should have the time and experience to verify the intricacies of the schedule or hire a CPM consultant to do the same. If any of these elements are not available, then approval authority is strongly not recommended. In both cases though, to minimize front-end loading in cost loaded CPMs, the Contracting Officer should remain the approval authority for the assignment of costs.

3.3 CPM Schedule Format

Few people realize the significance of scheduling specifications to a successful project. Well drafted scheduling specifications are critical to the ability of the parties to achieve their joint goals of timely and economical construction. Further, well drafted specifications should meaningfully address necessary elements of the scheduling process. They should require the contractor to commit the necessary skills to the scheduling process, develop a plan for executing the construction and a network schedule that implements the basic scheme or game plan for construction with necessary relationships, and enforce a commitment of the parties to a specific schedule for executing the work, measuring progress of performance, and grappling with necessary issues during construction (9:485). With CPM schedule development, the CPM scheduling specifications should address two basic areas; the CPM schedule format and CPM activity development. Other scheduling specification areas such as updating, revisions, and submission requirements will be discussed in Chapter 4.

As simple as it may seems, the first scheduling format requirement should address the completeness and reliability of the CPM schedule. The decision rendered by the New Jersey Superior Court in *Dobson v. Rutgers* illustrated the importance of complete information in a construction schedule. The court ruled that no schedule will be accepted by a court to either prove or refute an alleged construction delay unless it is complete (4:77). In this case, the contractor did not include procurement activities as outlined in the specifications, hence, the court considered the schedule to be incomplete. A court may even accept the most complete schedule even if it was not what the contractor used to construct the project. In light of this, the CPM schedule submitted should be used to manage the project and not merely represent a computer software exercise of a computer technician. It is not uncommon for a contractor to submit one schedule to satisfy the initial obligations of the contract, yet develop other schedules to manage the project. This should be unacceptable and prevented. The specifications should clearly identify that the submitted CPM schedule should be the schedule used by the contractor for planning, organizing, and directing the work, reporting progress, and requesting payment for work completed. The specification should prohibit actual start and finish dates from being automatically updated by default mechanisms that may be included in CPM scheduling software systems. Actual dates on the CPM schedule should match those dates provided from the contractor's quality or daily reports.

To be protected from "right to finish early claims", the specification should require the CPM schedule to extend from the contract award to the contract completion date. The CPM schedule should identify the projects critical activities. Critical activities will form a continuous chain through the network known as the "critical path" (4:23). Critical activities are not necessarily the most difficult nor the most important project activities. They merely represent the longest continuous performance path(s) through the network. The path may fork into two or more paths. Any delay in the finish date of a critical activity will automatically delay the project completion date by the same amount of time. It is important that one is able to recognize the true critical path and not be misled by peculiar idiosyncrasies of the logic. The logic may indicate an activity as critical, however, realistically it is not critical to the completion of the project. In this case, the logic should be revised to reflect the true logically critical path.

Another significant area the specification should address relates to the reporting requirements for float and the provisions for the use of float. One of the greatest pitfalls of most scheduling specifications is not properly defining who owns the float. The flexibility between activities with non-matching early and late dates is called float. Thus, float is a measure of the capability for a given activity to have its performance extended or delayed. Alternatively, float is a measure of "criticality" for an activity. The less float an activity has, the more critical it is and vice versa. Those activities which have no float are critical activities and cannot be delayed without delaying the project completion. There are two types of float for an activity; total and free float. Total float represents the difference between the early and late finish or the early and late start dates. Total float is the amount of time by which an activity can be delayed without effecting the project completion date. Free float represents the difference between the early finish of one activity and the early start of a subsequent activity. Free float is the amount of time by which that particular activity can be delayed without delaying the early start of the subsequent activity. Elimination of free float does not eliminate total float in an equal manner. Clearly, activity total float is of great concern to all parties which inherently recognizes the dynamic nature of the CPM process. Thus, the scheduling specification should identify that all float is an expiring resource available to all parties on a non-discriminatory basis and that it is not time for the exclusive use or benefit by any party. To minimize unrealistic relationship, float suppression techniques such as zero float constraints, multiple open activities, and negative lead/ lag relationships should not be allowed.

3.4 CPM Activity Development

The CPM Schedule should reveal the order, relationship of activities and the sequence in which the work is to be accomplished as planned. Detailed networks should include activities for construction work, the submittal and approval of materials, samples, delivery of Operation and Maintenance manuals, training to be provided, shop drawings, the procurement of critical material and equipment, receipt of materials with estimated procurement costs of major items for which payment of materials will be requested in advance of installation, fabrication of special material and equipment, and their installation and testing. Also it should show activities indicating Government related approvals, inspections, utility tie-ins, and Government Furnished Materials and Equipment (8:3).

The CPM schedule should start no earlier than the contract award date while the overall imposed completion date and the completion of the last activity should be constrained by the contract completion date. It should be noted that by constraining the completion date, if the early finish of the last activity ever falls after the contract completion date, then the float calculations will reflect a negative float on the critical path. It is important to realize that all activities with total float less than or equal to zero are critical. The more negative, the more critical. The CPM schedule should identify the number of work days in a week and the holidays and other non-work periods to be considered. In order to maintain effective manageability of individual activities and the schedule, individual construction activities should not exceed 30 work days. Activities that do not involve any duration such as a "Start Project" activity shall show zero duration. Seasonal weather should also be considered, identified, and included in the planning and scheduling of all work influenced by high and low ambient temperatures and/ or precipitation.

The fact that contractors are dealing with the real world with real resource limitations, personnel, money and other resources are key components to CPM scheduling. In fact, reasonable resource leveling is a necessary component for a CPM to be used as a project planning tool and to evaluate delays. Thus, all activities should be manpower loaded including an estimate of the average number of workers per day. The decision by the Court of Federal Claims in *Neal & Co., Inc. v. United States* demanded that CPMs include resource leveling constraints as an element of the scheduling process. In addition, the court ruled that a previously approved CPM should not be used as a basis for evaluating delay where necessary crew constraints and resource allocation were not included in the approved CPM (9:481-482). All activities should be cost loaded for payment purposes and that the contractor should only be paid from the cost loaded CPM. Indirect and direct cost data should be established relating to each activity time so that the most economical project schedule can be established. The values associated with individual activities should be broken down and listed by material, labor, equipment, and inspection/ testing costs. In situations where inspection and testing activities are necessary, values of inspection/ testing should not exceed 10 percent of the related construction activity value. Any activities that post progress out of sequence should not be paid until either the schedule logic is corrected or the predecessor activities are completed.

To effectively manage the individual activities and the complete project schedule, detailed sorting capabilities and appropriate level of details are especially necessary. Appendix C illustrates several categories of the appropriate level of detail necessary for a sample project. All activities should be identified by the party responsible (RESP) to perform the work. Normally, these activities should not belong to more than one party such as the contractor, subcontractor, or government agency to list a few. Activities should be identified by the work area (AREA) and section of the project (SECT) in which the activity occurs. An example of this would be if ductwork is planned to be installed on the 3rd floor of Wing B of a building. Activities should also identify the construction discipline areas (CDA) involved. For example, the installation of ductwork or the placement of concrete floor slab should have a CDA of HVAC or CONCRETE, respectively. In cases similar to the construction of a floor slab, CDAs should be identified as detail as possible. Detail should include separate CDAs for the formwork, rebar, and concrete activities. All activities should be identified according to the category of work (CATG) which best describes the activity. Category of work refers to the procurement chain of activities including such items as submittals, approvals, procurement, fabrication, delivery, installation, start-up, and testing. In many cases the project requires performance in phases (PHAS), hence, activities should also be identified by the phases of work in which the activity occurs. Activities should also be included in the proper flow of work (FLOW) if one exists. In order to minimize confusion and maximize sorting effectiveness, individual activities should not be assigned to more than specific level of detail. For instance, if electrical conduit is being installed in the above ceiling space for the length a floor, yet the floor is divided up into Phases A and B, this activity should not indicated both phases in the activity phase of work code. Instead this activity should be divided into two separate activities, each with its own phase of work code. Additional sorting categories are advisable if time and costs permits.

3.5 Submission Requirements

Depending on the size of the project, a preliminary and complete CPM schedule may be required. If a preliminary CPM schedule is required, the time period covered will also vary with the size and duration of the project. A reasonable guide is for the preliminary CPM schedule to define the planned operations during the first 120 calendar days after contract award. This schedule should be submitted within 30 calendar days after contract award. The general approach for the balance of the project should be indicated. If cost loaded, the cost of activities expected to be completed or partially completed before the submission and review of the completed CPM schedule should be included. Once reviewed, the preliminary CPM schedule should be used to plan and manage the project until the completed CPM schedule is submitted and reviewed. The completed CPM schedule should be submitted within 60 calendar days after contract award. The preliminary CPM schedule should be used for requesting progress payments for a period not to exceed 120 calendar days after receipt of contract award. Payment requests after the first 120 calendar period should be based upon the complete approved CPM schedule. The underlying logic is that if the preliminary CPM schedule covers the first 120 days, then when the completed CPM schedule is submitted for review, 60 days will be remaining on the preliminary schedule. The Contracting Officer is authorized up to 30 days to review the schedule and provide any comments. Once returned to the contractor, he will have at least 30 days to review, discuss, and incorporate the comments into the final CPM schedule.

The CPM schedule submittal should consist of time scaled logic diagrams, narrative describing the schedule, and accompany mathematical analysis sorted to include a tabulation of each activity shown on the detailed network diagram. Additional sorts should include all activities with budgeted data sorted by CDA, contractor's monthly payment request by activity with summary costs sorted by CDA, "S" curves showing projected early and late cash flow and earnings to date for complete project, equipment utilization forecast, and total float report from the lowest to highest total float sorted by CDA. Sorts also should be provided to illustrate projected manpower loading and resource profiles and percent of activity completed.

Depending on the specific circumstances, normally four copies of the timed scaled logic diagram, mathematical analysis, and required sorts are sufficient for review and documentation. Additionally, an electronic copy of the project on diskette should be required.

CHAPTER IV

MANAGING AND UPDATING THE CPM SCHEDULE

4.1 Updating Fundamentals

Failure to incorporate changes in the work and time extensions prevents a CPM schedule from reflecting the current status of work performed. The boards and courts are fully aware of the dynamic nature of the CPM process. The United States Claims Court, in *Fortec Constructors v. United States,* recognized that if the CPM is to be used to evaluate delay on the project, it must be kept current and must reflect delays as they occur, ... Reliance upon an incomplete and inaccurate CPM to substantiate denial of time extensions is clearly improper (8:437). The primary purpose of updating the project schedule is to evaluate the current status of the work, based on progress to date, and to forecast a realistic project completion date given that progress. The updating process, in practice has suffered from a number of maladies. They include the failure of the owner to verify information contained in the submitted updates, the failure of the contractor to properly record actual dates, and the use by the general contractor of logic override without making appropriate logic changes in the network. Specifically, the best device for the parties to address these problems is the joint updating meeting, where both parties are required to review the information contained on the update that is proposed for the reporting period. The CPM scheduling specifications should clearly identify the requirements to update the schedule on a monthly basis. During updating a data date should be established. The data date is the date for which progress is reflected in that update. Contractors routinely use the 25th or the end of the month as a data date for the update (6:426). A copy of the original CPM schedule should be maintained to use as a target schedule to compare planned against actual progress.

4.2 Activity Updating

The typical process used to update construction and procurement activities is the percent complete. Some projects update activities by duration complete. This can be extremely erroneous because a contractor may have underestimated the duration of an activity or been inefficient during this reporting period which would cause overpayment for that particular activity. For example, an activity may have expended over 50% of the duration, yet the activity is only 10% work in place complete. By updating all the activities within the schedule on which progress was realized during the reporting period and then recalculating the update, the schedule is updated as of its data date. Typically, a walk through inspection of the project by the contractor, subcontractor, and Contracting Officer's representative determines the percent complete of the construction activities.

As updates are performed by incorporating percent complete data, the contractor should constantly reevaluate individual activity durations, resource and budgeted cost allocation to make certain that they are still accurate. Since percent complete calculations include the activity's budgeted costs, it is strongly advisable to never change the budgeted cost allocation on an activity that has been statused. For example, if an activity with a budgeted cost of $10,000 was statused three months ago at 30%, then $3,000 was paid for progress on this activity three months ago. If new data showed that this activity should have been budgeted for $14,250, one would want to change the budgeted cost from $10,000 to $14,250. However, changing the budgeted cost data after it has been statused will change the percent complete and cause inconsistent percent calculations and general confusion. Changing budgeted costs for "unstatused" activities is acceptable, however, justification should be required and only approved on a case by case basis.

4.3 Contractor Logic Revisions

The updated schedule should reflect the contractor's game plan to accomplish the work. Often a contractor needs to revise his logic during the course of work that may involve addition or deletion of activities, changes in he sequence of work, delays, or a myriad of possible influences. The failure of the CPM scheduling specifications to specify the requirement for logic revisions to be submitted for approval can cause major conflicts and misunderstandings between the parties. Thus, the CPM scheduling specifications should clearly identify that if logic or budget changes are desired, the Contracting Officer should be notified in writing stating the reasons for the changes. All logic and budget changes should be approved by the Contracting Officer prior to incorporating changes into the CPM schedule. If these changes are determined to be major in nature, the contractor should be required to revise and submit for approval specific diagrams and sorts without any additional cost to the Contracting Officer. A change may be considered major in nature if the estimated time required or actually used for an activity or the logic is varied from the original plan to a degree that there is a reasonable doubt as to the effect on the contract completion date (8:12). As noted previously, the contractor should not be permitted to override the logic of the network by using "Progress Override" alternatives. These alternatives may not show apparent delays to the project because it automatically modifies otherwise valid sequential logic to one of concurrent logic.

The problem of the contractor overriding the logic in the CPM schedule and changing activity relationship types, i.e. from Finish to Start to Start to Start, without making appropriate logic and resource changes requires continuous attention by both the contractor and the Contracting Officer. The scheduling specifications should prohibit this type of behavior. To protect the interest of the owner and keep the contractor honest, a logic tracking program such as Claimdigger should be used to verify that the contractor is only making authorized revisions to the network.

4.4 Contract Modifications and Change Orders

To the extent that the project has been changed through a change order or contract modification, the schedule should be revised to incorporate that change. When a contract modification is required, the contractor should submit proposed revisions (fragnet) to the CPM schedule reflecting the impact. An example of the fragnet format for proposed revisions is identified in Appendix D. The best method to incorporate contract modifications is to create a separate activity for all contract modifications. These new activities should include an appropriate description of the modification, the modification number, and a predecessor and successor relationships linking them back into the CPM schedule. They should include appropriate durations, manpower loading, and cost allocation. Additionally, they should have defining sorting capabilities similar to the original activities, however, their category of work code should indicate them as contract modifications. Appendix E illustrates several examples of properly defining contract modifications with appropriate sorting categories and relationships. It is important to recognize that if procurement and delivery are significant, then a separate activity should be added to the network to reflect it. Modification sub-reports or fragnets should be submitted with the contractor's cost proposal for all modifications showing these relationships and related impacts to the project schedule and completion date. The CPM schedule should be rescheduled after the sub-report or fragnet is inserted to analyze impact. Once the sub-report or fragnet is approved, it may be permanently included into the schedule.

4.5 Schedule as Notice

Courts have been known to accept the CPM schedule as implied notice of performance deviations and disruptions. The schedules that have been updated frequently and submitted to the Contracting Officer may serve as notice of alleged delay and impact to the project schedule. However, for the updated CPM schedules to constitute notice of delay and impact, the CPM update schedule must be shown to reasonably call attention to the delay and impact (4:157).

4.6 Time Extensions

One of the most intense and unproductive areas of conflict in the area of scheduling specifications relates to the issue of project time and the failure to define the baseline and methodology for evaluating time extension requests on projects. Specifically, the failure to provide a definite methodology for evaluating time extensions has led to unnecessary and completely unproductive gamesmanship on the part of the participants to the project. Projects where parties argue over methodology of evaluating time extensions are one of the worst tragedies in the construction industry (3:67-68).

In the event the contractor requests an extension of the contract completion date, he should furnish such justification, CPM schedule data and supporting evidence necessary. As noted early, project float is not time for the exclusive use or benefit of either contractual parties. Thus, an extension of time should be granted only to the extent that equitable time adjustments for the activities affected exceed the total float along the CPM schedule paths involved. If properly justified, the time extension should be granted and the schedule should be revised to reflect the time extension. Actual delays that are found to be caused solely by the contractor's own actions, which result in the extension of the CPM completion date, will not be a cause for a time extension to the contract completion date.

Unless the project completion date is sincerely critical, a Contracting Officer may want to approve any request for noncompensible time extensions. Essentially, if the contractor asks for twelve days for bad weather, a sophisticated Contracting Officer should grant this request. As difficult and unpleasant as it may be to admit, in practice job completion and contract completion dates have little to do with each other (6:48-49). Such an action serves three purposes. First, it provides the Contracting Officer extra time to incorporate additional changes during the noncompensible time extension without effecting the project completion date. Secondly, it improves working relationships between parties and helps maintain a partnering environment. Thirdly, it gives the appearance that the Contracting Officer is reasonable, understanding, and acquiescent. Perhaps it means the loss of liquidated damages, but experience is that liquidated damages are too low to be of substantive value and they normally are not returned to the project budget.

4.7 Submission Requirements

The contractor should submit monthly interval reports of actual construction progress by updating the time scaled logic diagrams and required sorts as described in section 3.5. Depending upon the size of the project, some projects should require a biweekly work schedule (60 day look ahead) that provides a more detailed day to day description of upcoming work. The work plans should be developed from the approved CPM schedule including all approved modification impacts, tied to the CPM schedule activity numbers. The contractor should submit a narrative report describing progress and current and anticipated problem areas and/ or delaying factors with their impact together with an explanation of corrective actions taken or proposed. Further, he should submit a projected report of scheduled activities to be started, in process or completed during the upcoming reporting period. Additionally, the entire project update network should be electronically submitted on a 3.5 mm disk to the Contracting Officer for review.

CHAPTER V

MONITORING AND ANALYZING PROGRESS

5.1 Project Reports

The gathering, reviewing, sorting, and compiling of information needed to perform the schedule analysis usually comprises about 85 - 90 percent of the effort in the long process of delay analysis. The completeness, accuracy, and detail of this information is critical in identifying and analyzing causes and responsibilities for delays. During the life of the project it is critical to ensure daily and monthly project reports are complete, promptly submitted and are properly documented. The most fruitful files for obtaining key project information include the Project bid and estimating files, Contractor's Daily and Quality Control reports, Requests for Information (RFIs), Change Orders, CPM scheduling files, Payrolls, Submittal Transmittal log, Meeting minutes, Correspondence files, internal memos and personal logs. For most projects, establishing some type of document control system is essential.

5.2 Monthly Overview

There are many ways in which a schedule can be used to measure delays and to demonstrate impacts of project delays. They range from simplistic to complex. The methods that is the easiest to explain often suffer from simple-minded logic that distorts reality. The most complex are often the most accurate, yet they may be difficult to understand and explain. However, in both extreme cases, establishing a continuous record of the trends, happenings and problems on a project are of the utmost importance. The beauty of the CPM process is that it is dynamic and allows the executor of the schedule at any given point in time to react to events as they change so that resources can be applied in a different fashion. Because of its dynamic nature, on a monthly basis a Contracting Officer should perform and maintain his own scheduling analysis from the CPM schedule updates provided by the contractor. To be effective, the scheduling analysis should include a record of diagnostic information, historical trends, logic changes, comparison of performance to date to the original target schedule, manpower availability and usage, and any problem areas. Appendix F illustrates key excerpts from a CPM Monthly Overview for a sample project. These excerpts cover the following areas.

5.2.1 Diagnostic Information

Diagnostic information involves basic schedule fundamental data that allows the Contracting Officer to effectively monitor the growth, activity, criticality and direction of the CPM schedule. Appendix F, page 71 illustrates a record of diagnostic information which includes the total amount of activities in the schedule, the quantity of activities started, completed and in progress during this period, and the percentage of critical activities. In addition, the project and schedule projected completion dates and the percentages of Work In Place (WIP) based on money earned and time to the project and schedule projected completion dates are included in the diagnostic information. This information provides a macro overview of the contractor's rate of progress, ability to start and complete activities, and effectiveness to manage the critical path. Further, it identifies the differences between the project completion and schedule completion dates and highlights payment uncertainties by establishing a comparison between the money earned and time expended.

5.2.2 Historical Trend Data

Establishing and monitoring historical trends can permit early detection of potential problem areas, schedule criticality and delays to the project completion date. Appendix F, pages 71 -73 depict several historical trend information. One of the best methods to monitor these early detection signs is to identify the quantity and percentage of activities with various total floats. Dividing the project activities into four total float categories; total floats less than or equal to 0, 7, 14, and 30 days should be sufficient to effectively detect early warning signs. Activities with total floats less than or equal to 0 days will identify the project's critical path. Activities with total floats less than or equal to 7 and 14 days, will indicate the contractor's effectiveness and ability to manage the shorter range daily activities. They also provide an early sign of the project's degree of criticality in the near future. Activities with total floats less than or equal to 30 days, will indicate the contractor's capabilities to manage and plan for longer range activities. Clearly, the more total float an activity has, the less critical it is to the project completion date. Hence, unless the project is nearing completion, a trend of increasing activities with less total float may be an early warning sign that the project may be in trouble and may need to increase resources or alter the "game plan".

The Contracting Officer should maintain trend data regarding workdays lost, during the period and cumulative from the original CPM schedule and the responsible party for such delays. Additionally, trend data for work activities started, in progress, and finished can be important. This data identifies whether the contractor is starting and completing activities in a reasonable fashion. Both parties should discuss and agree on this information prior to the ensuing reporting period.

5.2.3 Logic Revisions

Altering the game plan may involve major or minor logic revisions. Contracting Officers should not be overalarmed by logic revisions because "things do change". To update an outdated illogical CPM schedule serves little to no purpose. Thus, it is critical to revise the schedule, keep it current, and make it reflect the current plan and schedule for accomplishing the work, and, in turn, the update should generate accurate information. In addition to the contractor's justification and explanation for the logic change, the Contracting Officer should record which updated CPM schedule the logic change was incorporated into and who generated the logic change. He should also identify the key subcontractors effected, analyze any fluctuations to the total float trends, and any changes to the quantity and type of critical activities and direction and/ or extension of the critical path. Further, a logic tracking program, such as Claimdigger should be used to verify that the contractor is only making authorized revisions to the network. To achieve maximum effectiveness, inform the contractor that a logic tracking program will be used . Hence, it should then only serve as a deterrence and not a defense.

5.2.4 WIP Curve Comparisons

Identifying work in place (WIP), money earned and paid, and projected early and late completion dates for the overall project and key construction discipline areas (CDAs) and comparing them to the original CPM schedule are extremely essential. Using the advance sorting capabilities of the CPM schedule, critical CDAs and the responsible contractor/ subcontractor are easily identified. This information provides significant insight to the progress on the project and in critical CDAs. It also identifies whether the project and critical CDAs are ahead, behind, or on schedule. Once sorted, this data should be placed in a graphical form resembling an S curve as illustrated in the example project in Appendix F, pages 74 - 75 . These S-curves represent the WIP curves for the complete project and one CDA; drywall contractor, respectively. The WIP curves reveal the differences in earned and planned WIP and illustrate the early and late projected WIPs required to maintain schedule. In this example project, both the project and CDA are behind schedule.

The CDA WIP curves identify progress and earned value for the respective contractor/ subcontractor. They also reveal CDA interdependence and can forecast impacts and delays to other construction discipline areas. For example, mid way through a project, the large mechanical ductwork subcontractor may be 10% behind schedule, however, as it may be, his activities are not yet critical. To finish on time, he plans to double his resources so that several activities which once were planned to finish successively, will now finish simultaneously. On the other hand, the small ductwork insulation subcontractor with limited resources planned to start and finish his activities successively. Clearly, the revised plan of the ductwork subcontractor's to finish simultaneously will effect the insulation subcontractor's work activities. To avoid delaying the completion date, the insulation subcontractor will either have to at least double his resources or work overtime to maintain schedule, hence, increasing his expenses. In many cases, the insulation subcontractor may not be able to do either, hence, the project completion date is effected.

5.2.5 Manpower Usage and Availability

Monitoring the project and subcontractor manpower availability and usage on the project is another essential area the Contracting Officer should be aware of. Typically, the contract requires the contractor to record his manpower usage on a daily basis in either the project's daily or quality control reports. These should be periodically verified with the contractor's payroll submissions. Appendix F pages 76 - 77 identifies the manpower usage for the example project and one CDA. The number of workdays and workers used per month are required to calculate the average amount of man-hours and workers used per workday. These averages should be compared to the manpower loading in the schedule to determine whether additional manpower is required or activity manpower loading should be revised. In many cases, when contractors fall behind schedule they believe they can simply higher more people to regain schedule. To their surprise, they realize skilled manpower may be limited, therefore, they are unable to obtain the necessary amount of resources. Thus, causing delays to the CPM schedule completion date. In conjunction with the WIP curves, manpower usage data can identify the contractor and his subcontractor's true ability to achieve a specified completion date.

Manpower usage should also be compared to activity durations. Since durations are developed from the average number of workers per day, activity durations may require revision due to the contractor's inability to obtain the necessary amount of resources to achieve the estimated duration. Further, manpower usage data may also reveal signs of problems with obtaining skilled craftsman, problems with the labor union, labor management problems, or poor project planning.

5.2.6 Monthly CPM Schedule Briefs

The Contracting Officer's CPM Schedule Engineer should meet with the contractor and key personnel on a monthly basis to discuss and review the contractor's updated schedule and analysis identified in paragraphs 5.2.1 through 5.2.5. Key issues, problem areas, concerns and coordination items should be identified and discussed in an open and honest manner. It is recommended that a letter acknowledging conformance to the analysis should be signed by both parties.

CHAPTER VI

CPM SCHEDULE ANALYSIS

6.1 Schedule Analysis Introduction

In all types of dispute resolution systems, one's claim must be proven rather than merely alleged. Schedules can play an important role in proving or refuting delays and other impact claims because they can provide a detailed medium for comparing and measuring time and intent. Since their dramatic popularity over the last 25 years, schedules have been grasped as the medium and method to prove delays in the United States and in other countries (3:264). A few courts have not yet totally embraced the significance of the schedule to aid them, mostly because they either do not understand the scheduling process or are not completely comfortable with its use to assist them. However, more often than not the courts and boards have shown increasing level of sophistication and knowledge in using this tool to aid them during the decision making process.

Complying with the legal requirements during the performance of a schedule analysis is simply one consideration in the complex process of determining the reasons for project delays and the responsible parties. In most cases, making an accurate determination of the delay is of utmost importance. From there though, the methodology to obtain the most accurate results will vary dramatically from one scheduler to another. In a field where there is little standardization, various techniques to analyze schedules exist. Even the names of similar techniques differ from one analyst to another. Many schedule analysts consider their techniques as proprietary and make every effort not to publish or disclose the actual process to anyone. This protective attitude coupled with the adversarial climate in which most analysis is evaluated, has limited the growth and improvements in performing scheduling analysis (7:2).

6.2 Basic Parameters

Many courts have dismissed alleged construction delays because they did not properly address some basic parameters. There are three basic parameters that apply to practically all types of CPM schedule delay analysis. Depending on the type of analysis, one parameter may bear more weight than another. These basic parameters include ensuring the correct as planned schedule is selected, following logical procedures during scheduling analysis, and guaranteeing the accuracy of the schedule analysis must be evaluated in relation to the type of analysis being performed.

6.2.1 Selecting the Correct As-Planned Schedule

Many projects create numerous different schedules, especially during the early stages of work. Besides the main project schedule, there may be many work and subcontracting schedules on the project site. Selecting the correct as-planned schedule may make all the difference between having your schedule analysis rejected or accepted. Generally, the correct as-planned schedule must show completeness. Since preliminary schedules, subcontractor schedules, and schedules that do not identify procurement activities only illustrate portions of work, they are not considered to be complete schedules. In situations where the contractor failed to provide a complete comprehensive schedule, the schedule analyst may create an as-planned schedule based on the best information available. This doesn't favor the contractor because it implies that the contractor failed to adequately plan and schedule the project, hence breaching his contract by failure to perform.

In projects where schedules are developed, they should reflect the contractor's game plan to execute and control the project. Many "remarkable" schedules have been developed in order to meet the initial requirements of the contract, however, the progress on the project have not coincided with the logic in the schedule. Many court cases have ruled that a schedule that does not represent the planned approach of the contractor cannot be used to analyze delays. However, there are a few cases sited like *Blackhawk Heating & Plumbing v. United States*, where the Board of Contract Appeals utilized the contractor's most complete schedule even though it was not what the contractor used to construct the building. Again, this is not in the contractor's favor.

Further, the schedule should be free of planning and technical errors. "Obvious planning errors" are easily corrected and are usually not questioned when the analysis is evaluated in trial or arbitration. An example of an "obvious planning error" includes a plan to erect all the structural steel prior to completing the foundation on which the steel sits. Hence, "obvious planning errors" should only involve sequence impossibilities and not just an unadvisable or new approach. This alone may change the schedule and delay the contract completion date, which would be the contractor's responsibility. Additionally, there is a wide variety of technical errors that include open starts and finishes, "typo" type errors, incomplete relationships, missing relationships, etc. which may also effect the schedule. These errors should be corrected as well. "Technical errors in a CPM schedule used for analysis if found during the litigation process can be fatal to one's evidentiary process" **(7:13).**

6.2.2 Following Logical Procedures

When inserting the delays into the schedule, they should be analyzed in the chronological order in which they occur. When inserting more than one delay, it is important to determine the effect of previous delays prior to inserting later ones. Determining the start date of various delays and accurate logic interdependencies are challenging, however, are extremely important to the results of the analysis. Hence, a certain amount of judgement is required on the part of the analyst. With respect to the start date of the delay, typically, they are determined by when the delay effects the work on the project. A few schedule analysis methods place all the delays into the schedule at one time. This simplified approach can be appropriate if the delays are concise, independent and the "ripple effect" does not require independent calculations. Generally though, this method is used for simple or low cost analysis.

Once delays are inserted into the schedule, all delays of any reasonable magnitude should be analyzed for impact. Even though a particular delay may have a short duration, the impact on the schedule may be much greater. The analysis must address key issues of whether activity durations or labor requirements were effected or there was a lost of efficiency. Each delay should be measured separately since different parties may be responsible for different delays. Regardless of the responsibility for the delays though, different results should not be arrived at because of the responsible party. Some delays on a schedule path that has substantial float with no anticipated ripple effect or resource costs can be overlooked.

Procedures must be established to segregate critical and non-critical delays. Critical delays effect the project's critical path. They involve changes to the project completion date and requires the contractor to be on the project site longer than anticipated by the original schedule, hence, critical delays are claimable. Non-critical delays, also known as internal delays, do not effect the project's critical path. They don't effect the project's completion date but do delay a portion of the work. They may delay an interim completion date or simply delay the time at which the contractor planned to demobilize a piece of equipment. Non-critical delays may also be claimable, especially if the contract specifications don't identify that all float is as expiring resource available to all parties on a non-discriminatory basis and that it is not time for the exclusive use or benefit by any party.

Further, concurrent delays must be identified and evaluated as well. In delay claims, delays may be considered concurrent when there are two or more independent delays during the same period. Concurrent delays may occur during any part of the project performance period, not necessarily at the same time. Thus, a concurrent delay may occur during the same period as another delay, but they may also include any delays that contribute to the overall project delay, whether one delay overlaps with another or not. The period of concurrence is the period of project performance, not just the period during which any individual delay may have occurred (7:15). Once a delay has qualified as a concurrent delay, it must be apportioned, that is, it must be determined whether all or only part of the concurrent delay will be permitted to offset against the claimed delay.

6.2.3 Accuracy of the Analysis

The accuracy of the CPM analysis is dependent on the analysis technique selected, proper execution of that technique, accuracy of the original schedule and any status information used, completeness of the research, honesty of the schedule analyst, and the accuracy of the delay information available. It must prove the specific cause and effect relationship between the plan for performance and the variances in that performance. As the quality of information, schedules, technique, and research diminishes so does the accuracy of the schedule analysis results, even to a point of being 100% wrong.

CHAPTER VII

SCHEDULING ANALYSIS TECHNIQUES

7.1 Choosing a Scheduling Analysis Technique

Which scheduling analysis technique is best suited to a particular situation depends on the available information, available time to perform the evaluation, accuracy required, types of delays to be analyzed, level of detail available in the schedule that would be used, completeness and accuracy of project status information, the type of schedule available, the circumstances of the delay, cost, the amount of the claim and the rules of the particular scheduling clause. Whatever technique selected, the analyst must not only understand the specific method and be familiar with the details of the particular construction but also recognize the limitations of the scheduling process.

Generally there are six different schedule analysis techniques that are predominantly used in the industry today. The six different scheduling analysis techniques listed in the approximate order of their accuracy include the Bar Chart Analysis, CPM Update Review, Impacted As-Planned CPM Analysis, As-Built Review, Collapsed As-Built, and the Contemporaneous Techniques. Within these six categories, there are a great number of variations to the technique. Other techniques exist, however, they are either used infrequently in trial or arbitration or are project specific.

7.2 Bar Chart Analysis

Their are two types of bar chart schedule techniques; Subjective Bar Chart Review and Fenced Bar Chart techniques. The bar chart schedule analysis may be appropriate to use if a CPM schedule was not originally created or used on the project. Additionally, it may be appropriate if cost or time constraints do not allow a more accurate analysis or delays are very straightforward and occur on activities which are clearly critical or not critical. However, in order to effectively use this type of analysis, the analyst must be able to distinguish critical from non-critical activities and determine when delays are compounding. Also, it should be apparent that the bar chart creator carefully considered relationships during its development and all work within a bar is continuous.

The most simplified method of schedule analysis is the Subjective Bar Chart Review technique. Unbeknownst to many, this technique can be applied to a bar chart with only a few activities or one with hundreds of activities. Basically, the technique reviews each delay separately and applies them to the as-planned or updated Bar Chart schedule. The effect on the project completion date is then subjectively determined. The simplicity of the technique can be quite effective if the delays are relatively simple and can be logically attached to the activities listed on the bar chart. Straightforward delays such as the owner's failure to provide access to the project site can be easily illustrated and understood. More complicated delays though, such as the effects caused by a change order to add more ceiling work may be more difficult to analyze and convince others of its effect on critical and non-critical activities and the project completion date.

Due to the popularity of CPM schedules, Fenced Bar Charts are rarely seen as original project schedules. However, they are somewhat popular in the schedule analysis process for some type of delay claims. Typically, the original project schedule was a bar chart and the schedule analyst adds the "fences" to it to imply relationships and detail logic. The fences act as restraints or relationships would in a CPM schedule. They provide a neat more accurate appearance to the "laymen". However, since the schedule analyst inserts these fences, their placement are subjective to differences of opinion. Also, since most activities relationships are not true "Finish to Start" (FS) relationships, it is difficult to justify the degree of criticality between activities.

Attacking a bar chart analysis can be much more difficult than it seems. The analysis is so simple and straightforward that it sounds like it must be reasonable and correct. If the judge or jury don't have any experience with construction scheduling, this can be convincing because is consistent with the K.I.S.S (keep it simple s.....) concept. As a defense, one must find a delicate balance between educating the judge or jury of the limitations, inconsistencies and inaccuracy of this method, availability of more accurate analysis techniques while not overwhelming them with complicated particulars.

7.5 As-Built Review Analysis

This technique is similar to the CPM Update Review Analysis in that it makes a comparison between planned and actual durations, except it only uses the final CPM schedule update on the project. Essentially, it involves a comparison of the critical path of the final CPM schedule with the same activities on the planned schedule on the project to determine which activities took longer than planned. There are two types of As-Built Review Analysis; Completed Project CPM Schedule with Actual Dates and Created Project As-Built Schedule with Adjusted Relationships. Generally, this technique is applicable when logic sequencing in the final CPM schedule was not overly adjusted and its status information is believed to be correct, the schedule includes specific activities that include the delayed work, and when time or cost constraints prevent using a more accurate technique.

The first variation assumes that the critical path has always been in the same location throughout the project. While the latter, relies heavily on the schedule analyst's ability to recreate project progress. Once actual dates are established, the schedule analyst connects the schedule with relationships matching the dates used and using as much of the planned relationships as possible. He identifies the sequence of the project from these dates and then re-sequences the project the way he sees it. Clearly, this process is highly subjective and extremely easy to manipulate to achieve desired results.

The best way to attack either As-Built Review Analysis technique is to show the change in the critical path due to other contributory causes. Contributory causes

7.3 CPM Update Review Analysis

This technique does not involve any impacting of the schedules. Essentially, it is an inspection and explanation process. Generally, this technique is applicable when logic sequencing in CPM updates were not overly adjusted, status information in the updates is believed to be correct, the schedule includes specific activities that include the delayed work, and that CPM updates are available for all periods of delay. Further, this technique is applicable when time or cost constraints prevent using a more accurate technique.

Essentially the schedule analyst reviews the original and any updated schedules for the project in chronological order to identify any portions of the project where activities took longer than planned. The delays are extracted from the updates by comparing the planned versus actual durations, and determining the critical path from the updates being used for each individual delay. It is fairly a straightforward process if the CPM schedule includes accurate actual dates. However, if the CPM schedule does not include actual dates, then the schedule analyst must compare each update with the next to identify where the project's progress failed to equal the project planned. Once delays are discovered in the CPM updates, they are related to specific causes.

The best way to attack the CPM Update Review Analysis technique is to show other contributory causes to the additional time required to complete an activity. This is normally relatively simple because most projects have numerous problems occurring continuously. Contributory causes include coordination problems, late or incomplete material deliveries, contentious subcontractor relationships, and low company morale to list a few. Further, since actual dates are always subjected to great scrutiny, conflicting date information can also be used to show that the CPM updates are in error and unreliable. It is relatively simple to find conflicting information with regards to the start and finish dates of activities.

7.4 Impacted As-Planned CPM Analysis

This technique is probably the easiest CPM analysis technique to execute. The Impacted As-Planned CPM Analysis technique measures the effect of the delay on the contractor's planned or intended purpose and not his actual performance. Generally, this technique is applicable when CPM updates are not available, evidence reveals that the contractor executed the project in essentially the sequence and duration planned and the creation of updates cannot be performed with the available status information. Further, this technique is also applicable when updates have been performed, however, the scheduler may have manipulated or misrepresented status on the project to such an extent that the update status is totally unreliable.

There are several variations of this technique, however, essentially they follow the same principle. The best of these variations is when various delays are separated and formulated as events with time durations. The individual delays are added to the as-planned CPM schedule in chronological order. After each delay is added, the CPM software recalculates the schedule and determines the effect of the additional changes. The process is additive in nature and all previous impacts or delays are left in the schedule as the next delay is added. Adding all the delays in at one time and then recalculating should be avoided. This violates one of the most important and basic parameter of schedule analysis, that all delays must be analyzed in the order that they occurred.

Due to its unfairness and limitations, several landmark decisions in the 1990's have identified that this technique is no longer appropriate (5:447). Several courts have identified that the Impacted As-Planned CPM Analysis technique ignores all logic changes, critical path changes and deviations in planned durations and assumes that the contractor is not responsible for any concurrent or critical delays. It fails to require the contractor to accept responsibility for its own delays and gives the owner credit for excusable delays as well. Additionally, it fails to adequately identify when the contractor would have finished absent these delays.

The best way to attack the Impacted As-Planned CPM Analysis technique is to show that the contractor did not execute the project in the same sequence as planned and that the difference would effect the critical path. Further strategies include showing that numerous actual activity durations do not match the as planned activity durations and that these differences would effect the critical path. These strategies can be performed through researching project records, payroll information, daily logs, or even project progress photos.

7.5 As-Built Review Analysis

This technique is similar to the CPM Update Review Analysis in that it makes a comparison between planned and actual durations, except it only uses the final CPM schedule update on the project. Essentially, it involves a comparison of the critical path of the final CPM schedule with the same activities on the planned schedule on the project to determine which activities took longer than planned. There are two types of As-Built Review Analysis; Completed Project CPM Schedule with Actual Dates and Created Project As-Built Schedule with Adjusted Relationships. Generally, this technique is applicable when logic sequencing in the final CPM schedule was not overly adjusted and its status information is believed to be correct, the schedule includes specific activities that include the delayed work, and when time or cost constraints prevent using a more accurate technique.

The first variation assumes that the critical path has always been in the same location throughout the project. While the latter, relies heavily on the schedule analyst's ability to recreate project progress. Once actual dates are established, the schedule analyst connects the schedule with relationships matching the dates used and using as much of the planned relationships as possible. He identifies the sequence of the project from these dates and then re-sequences the project the way he sees it. Clearly, this process is highly subjective and extremely easy to manipulate to achieve desired results.

The best way to attack either As-Built Review Analysis technique is to show the change in the critical path due to other contributory causes. Contributory causes include contract delays, coordination problems, late or incomplete material deliveries, contentious subcontractor relationships, and low company morale to list a few. Further, since actual dates are always subjected to great scrutiny, conflicting date information can also be used to show that the final CPM schedule is in error and unreliable. It is relatively simple to find conflicting information with regards to the start and finish dates of activities. Additionally, it can be criticized for not considering the situation as it exited at the time of each delay.

7.6 Collapsed As-Built Analysis

This Collapse As-Built Analysis has been extremely popular because it has been very effective in arguing and winning delay claims for contractors, owners, and designers. The primary reason for its effectiveness is because it appears to be simple, easy to understand and based on pure facts. Since it utilizes as-built information, as-built dates, and as-built logic it seems to be accurate and correct. However, in reality, nothing could be further from the truth (5:497). Generally, the Collapse As-Built Analysis assumes the contractor would have built the project at the same speed and in the same sequence if the delayed hadn't occurred, durations represent continuous work, accurate as-built dates relationships can be determined and derived from the as-built dates, respectively and that the schedule analyst has interpreted the dates impartially.

Essentially, the project is taken exactly as it was built. Actual dates for all activities are matched up with the projects records; daily logs and quality control reports. Then the delays are removed from the schedule to determine when the work would have been completed had the delays not occurred. The difference between the actual as-built completion date and the collapse as-built completion date is the delay which would be attributable to the responsible parties. Individual delays are inserted into the collapse as-built schedule and analyzed to determine impact and responsibility.

The best way to attack the Collapse As-Built Analysis is by discrediting the conceptual foundation of the technique. In order to accomplish this, the theory and scheduler's technical execution of the logic diagrams must be attacked. Firstly, the assumptions that work would be done in the same sequence and at the same speed had the change not existed and durations represent continuous work is completely erroneous. In real life, contractors change their plan of execution often in an attempt to reduce cost and improve efficiency. Contracting is a constant process of contemporaneous planning, adjusting for small delays and problems in the field on an hourly basis.

Since dates are the primary information upon which the as-built schedule is based, a concentrated effort should be made on proving the inaccuracy of these dates. The reality of construction is that people rarely indicate when work is proceeding well or when new work is started and completed (5:497). Hence, the process is highly subjective. If the date information is in error the entire as-built schedule is in error. Conflicting date information may be found in meeting minutes, labor reports, delivery tickets, correspondence, other daily logs, inspections and purchase orders. Since there are hundreds of judgement calls made in the conversion of as-built daily log type information to as-built dates, changes to actual dates of activities changes the logic in the as-built schedule, which in turn, effects the entire process to produce dramatically different results. Further, in order for the schedule analyst to covert the as-built matrix into an as-built CPM schedule, he must add activities to represent changes and delays, add or delete activities for work not indicated in the daily logs, adjust activity durations and lag durations, split activities that was originally shown as one activity, add or delete relationships and change relationship types. With all of the subjective input, clearly, the schedule analyst can manipulate the CPM schedule to show any desired outcome. Investing some major effort and time to research conflicting information can destroy the collapse as-built analysis.

7.7 Contemporaneous Analysis

The Contemporaneous Analysis technique is by far the most accurate method of CPM schedule delay analysis (7:25). The goal of this technique is to develop a stop-action picture of the project each time it experiences a major impact to the schedule. No other schedule delay analysis technique can even come close to the comprehensive analysis of this technique. This technique, developed by the U. S. Army Corps of Engineers has many attributes not found in any of the other techniques. It can be applied to a project which is not yet complete and are very effective for analyzing and resolving project delays as they occur. Generally, this technique is applicable when the original CPM schedule and all CPM updates are available, schedule is detailed enough to allow accurate impacting, status information is as accurate as possible and time and funds are available to support this analysis. Additionally, any logic changes performed during the project were honest attempts to mitigate delays or to plan better ways to complete the project.

The procedure is guided by the concept that delays must be analyzed on the schedule in effect at the time the delay was started. Hence, schedules must be updated with real actual dates, durations, and sequences. This is critical because a contractor's plan for executing a project is constantly changing in reaction to current conditions on the project. These conditions include previous changes, weather, subcontractor problems, changed conditions, contractor's new approach, and so on. If all or part of the modified work does not fit an existing activity, new activities may be created and inserted into the schedule. This fragnet or subnet is tied into the CPM schedule with predecessors and successor relationships. The revised schedule is recalculated and used to determine new critical paths and project completion dates. From this revised schedule, time extensions and other effects of the delay can be determined. However, no time extension should be granted unless the project completion date was extended by the delay. Unlike the other techniques, the Contemporaneous Analysis technique properly allows for mitigation, acceleration, changed sequencing, changed critical paths, and even keeps track of time lost because of the failure to make adequate progress delay (7:31-32).

There aren't many documented ways to attack this technique. One can attack the accuracy of the actual dates, however, this may be more difficult under this technique than the others since actual dates are recorded at or before the occurrence of the delay. One can argue that the true delay or impact of a modification could not be effectively analyzed at the time of the occurrence. An example of this is an undefinitized modification for underground obstructions (delay A). In this type of modification, the complete scope of work is not clearly identified until after the work is completed, which in some cases may take months. Consequently, making it impossible to analyze at the time the disruption was occurred. Compounding this would be if another separate delay (delay B) occurred prior to definitizing the first modification (delay A). This delay (delay B) could not be effectively analyzed either. Since the undefinitized modification (delay A) couldn't be promptly analyzed, the schedule analyst would not be able to identify the compounding impact or ripple effect that this undefintizing modification (delay A) would have on the second delay (delay B).

Typically, these scheduling analysis techniques are used in delay, acceleration, and the right to finish early claims. However, regardless of the scheduling analysis technique used, the best scheduling analysis can fail if it cannot be properly and convincingly explained. Once the technique is selected and the intricacies have been incorporated into the analysis, the complex interrelationships must be communicated so that the judge, jury, or arbitrator can understand the results of the analysis.

CHAPTER VIII

SCHEDULE RELATED CLAIMS

8.1 Claims Introduction

Claims involving delayed or accelerated construction progress, and the contractor's right to finish early are widespread in the construction industry. The bottom-line is time means money. Interest rates, inflation, extended field and home office overhead are everyday concerns for owners and contractors. These issues are the primary contributors to the cost overruns that plague many construction projects. It is crucial for owners, contractors, subcontractors and any entity involved in the construction process to be able to recognize and distinguish among the various types of delays and understand their rights and responsibilities (3:167). CPM schedule analysis assist in determining delays, impacts, and responsible parties.

8.2 Delay Claims

Delay claims have been responsible for the majority of usage of CPM schedules in claims analysis. As a general rule, if a contractor agrees to do certain work within a specified time, but is prevented from performing the contract by the act or default of another party, the contractor is entitled to the economic loss sustained as a result of the delay (5:331-332). Economic losses can include extended home and field office overhead, extended equipment expenses, wage escalations and direct expenses to name a few. The extended duration of a project can result from a variety of causes.

Causes by the owner includes changes or defective plans and specifications, causes by the contractor includes poor coordination and management and submittal delays, and causes by neither party includes acts of God or war. These delays often increase both the time required to perform the contract work and the cost of the work.

A CPM schedule analysis is often used to assess or present a delay claim. The CPM schedule analysis must identify two elements if it is to be used to prove a delay. It must identify when the contractor would have finished his work without the Contracting Officer caused delay and subtracting the contractor caused delays.

8.3 Acceleration Claims

Many contractor claims are based on the theory of acceleration. Acceleration is a term describing the situation when an owner requires a contractor to complete by a date earlier than the contract completion date, as that date should be extended for excusable delays. There are two basic types of acceleration, actual and constructive. Actual acceleration occurs when an owner consciously directs a contractor to complete earlier than the contract completion date. Constructive acceleration occurs when an owner fails to grant a contractor time extensions to which it is entitled, and the contractor is required to achieve or strive for an earlier completion than the properly extended contract completion date. Constructive accelerations are more frequently encountered situations. Thus, acceleration may be a by-product of delay or other factors that justify a time extension that is not formally granted by the Contracting Officer.

Claims for acceleration have been long recognized by the courts and boards. The CPM schedule can assist the contractor in proving the three elements necessary for a contractor to recover for the increased costs of acceleration under the changes clause. The CPM schedule analysis should illustrate that the delays giving rise to the order were excusable, that the contractor was ordered directly or indirectly to accelerate, and that the contractor in fact accelerated performance and incurred extra costs. However, acceleration claims are disallowed where contract performance was behind schedule due to the contractor's own actions or delays.

8.4 Right to Complete Early Claims

A number of recent court cases have illustrated a trend of right to complete early claims. Where Contracting Officers prevent early completion, a contractor can use a CPM schedule analysis to seek to recover additional compensation. In all three cases, *Montgomery-Ross-Fisher, Inc v. United States, Green Builders, Inc. v. United States, and Sierra Blanca, Inc., v United States*, the contractor argued that not only could they have completed the project early if not for government delay, but that they also based their bids on the early completion schedule. The courts found that these contractors had a right to recover delay costs based on the scheduled early completion date since they showed its performance plan was reasonable. Additionally, federal authority has even recognized the contractor's right to recovery where the contractor finished early, but not as early as it had originally anticipated. The factual bases underlying these rulings were that the contractors had established their intent to perform the contract on an accelerated schedule in advance of the contractually mandated completion date and that this intent to perform was supported by the course of the contractors' actions and performance activities during contract performance that would have led to such an early completion absent Government caused delays (5:176).

Thus, Contracting Officers are becoming increasingly concerned about contractors' submission for approval of project schedules showing early completion. Contracting Officers are not totally without the ability to deal with these circumstances effectively. For schedules that require Contracting Officers approval, he has the right to reject a schedule that is submitted showing an early completion if the schedule is unrealistic or unreasonable (9:495). Additionally, if the bid documents and the CPM scheduling specifications clearly directs the contractor to provide a schedule that extends from the contract award to the contractual completion date and all float is as expiring resource available to all parties on a non-discriminatory basis and that it is not time for the exclusive use or benefit by any party, the Contracting Officers should be covered. Further, special language should be included in the time adjustment provisions similar to the Veterans Administration contracts. The provisions should identify that the actual delay must affect the "extended and predicted contract completion dates shown by the critical path and the network (9:496).

CHAPTER IX

CONCLUSION

9.1 Conclusion

The CPM scheduling technique is an extremely important tool for project management and monitoring progress. Over the years, it has become the accepted standard in the construction industry. The boards and courts have also shown their willingness to utilize this technique to identify delays and disruptions on projects, as well as the causes of delays and disruptions. The Bar Chart technique may be useful and acceptable on some small projects where there are few activities with linear type relationships, however, they do not offer the same critical advantages as the CPM technique. The complex logical interrelationships and dependencies amongst activities in the CPM technique makes it an effective tool for forecasting, directing, controlling, and measuring projects than the Bar chart technique. The beauty of the CPM technique is that it is dynamic and allows the executor of the schedule at any given point in time to react to events as they change so that resources can be applied in a different fashion and still achieve the planned project completion or minimize the effect of delays. However, the effectiveness and applicability of the CPM schedule to the Contracting Officer and their representatives are greatly reduced without clear and accurate guidance and direction with regards to its format, content, and rules for development and updating.

The fact that the CPM technique is acknowledged as the preferred method of the proof of delays is reflected in the increasing number of court and board decisions reflecting the use of this technique to assist the finder of fact. The courts and boards have fully recognized the dynamic nature of the CPM process. They have identified that if the CPM is to be used to evaluate delays and disruptions on the project, it must be developed accurately, kept current, reflect delays, and analyze impact. During the analysis, a specific cause and effect relationship between the plan for performance and the variances in that performance must be identified and proven.

For the Contracting Officer to effectively minimize the risk and quantity of schedule related issues, the contract specifications and bid documents should provide clear and unambiguous direction and guidance to the contractor in developing and maintaining his CPM schedule. Well drafted specifications and bid documents should accurately address the necessary elements and issues of the scheduling process so that both, the Contracting Officer and contractor have a schedule that they need, want and will use. An accurate schedule and effective scheduling management and control allows all parties to be closer to achieving their joint goals of timely and economical construction. By specifically addressing the CPM format, activity development, updating procedures and submission requirements as described in this report, the Contracting Officer and contractor will have a better understanding of where the project has been, where the project is, and where the project is going. Further, by specifically addressing definite baselines and methodologies with regards to key scheduling issues such as time extensions, logic revisions and early completion, major conflicts, unproductive gamesmanship and misunderstandings between all parties are minimized.

Not only are further risks reduced, but insightful information and significant documentation are produced when the Contracting Officer has the necessary resources to perform an independent detail analysis of the contractor's CPM schedule on a monthly basis. This dissection of the CPM schedule provides a true real-time study of the intricacies of the complex CPM schedule and its relationships, and the impact on time and cost to the project. Timely discussions from these extensive and thorough reviews permits all parties an opportunity to react to trends and problems and mitigate the effects of disruptions and delays. The information generated from the diagnostic data, historical trends, WIP curve comparison, manpower usage and availability, and logic revision analysis may also be crucial in justifying and protecting the Navy's contractual position during litigation, arbitration or mediation.

There are several scheduling analysis techniques available to assist the Contracting Officer in analyzing delay, acceleration, and right to finish early claims submitted by the contractor. One technique can be more effective and convincing than another depending upon the available information, available time to perform the evaluation, accuracy required, types of delays to be analyzed, level of detail available in the schedule that would be used, completeness and accuracy of project status information, the type of schedule available, the circumstances of the delay, cost, the amount of the claim and the rules of the particular scheduling clause. Each technique has its limitations, hence, Contracting Officers with the assistance of schedule analysts must be prepared to select the most effective technique to defend their own position and allow them to aggressively attack the weaknesses in the scheduling analysis technique the contractor chooses.

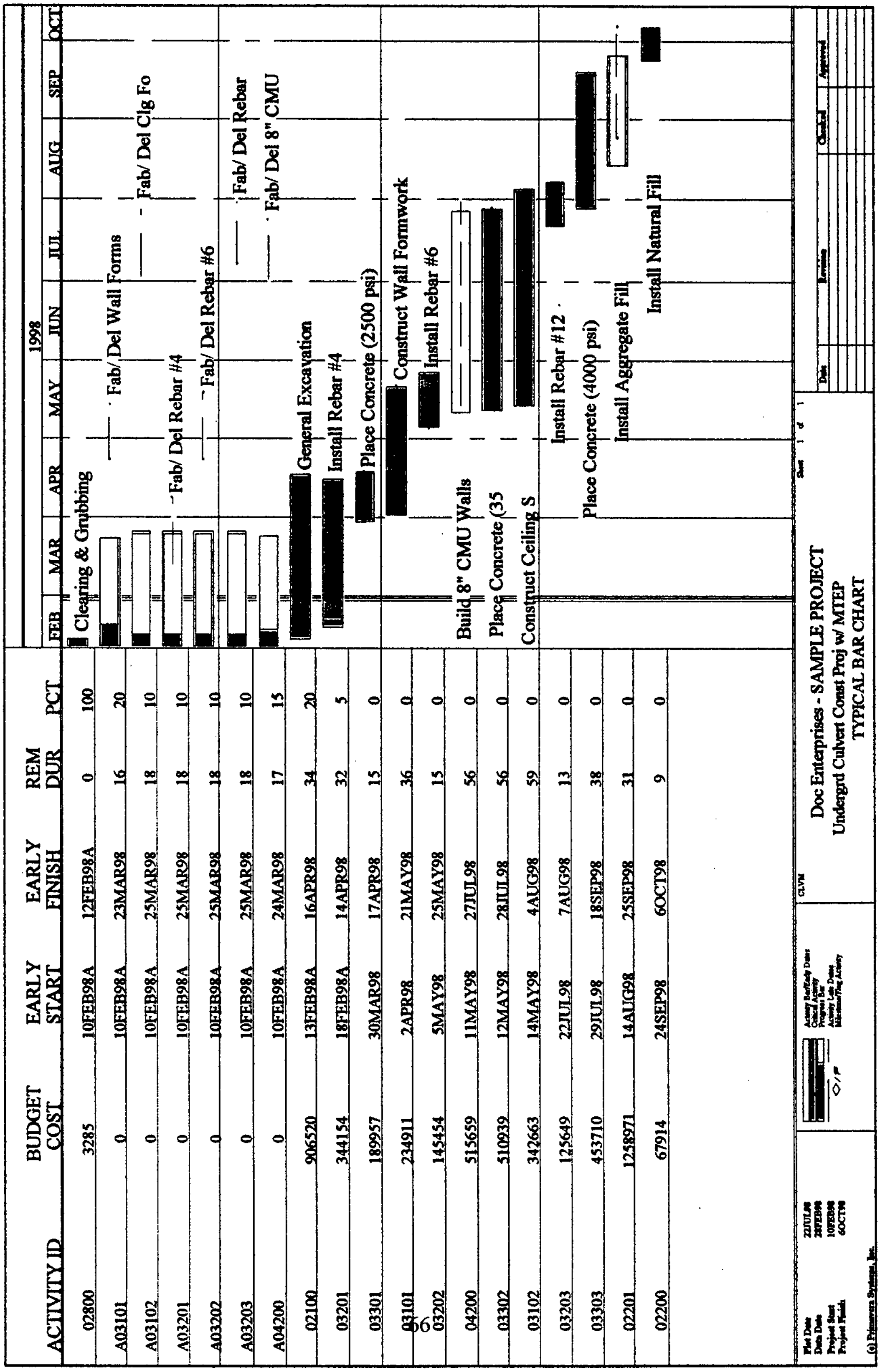
9.2 Recommendations

The current Naval Facilities Engineering Command (NAVFAC) guide specification and bid documents do not provide the necessary direction and guidance to the contractor to provide an accurate, useful and effective initial CPM and updated schedules for the project. Additionally, Contracting Officers are not equipped with the necessary resources and knowledge to provide them the ability to effectively approve, supervise, and analyze the contractor's CPM schedule and the impact of a change or disruption on the contractor's CPM schedule

In order to reduce these schedule related risks and improve the Navy's position during the claims process, the guidelines and information provided in this masters report should be incorporated in the current NAVFAC guide specifications and bid documents. The bid documents should identify a standard CPM scheduling software such as Primavera Project Planner or Suretrak to be used on the project and include a requirement for the contractor to provide a copy of the software. Additionally, NAVFAC should provide a more extensive and thorough CPM scheduling training program for Contracting Officers or their representatives so that they can perform the necessary analysis as identified in this masters report. Having these skills and experiences on staff will increase the Contracting Officer's abilities to identify schedule related problems that the Navy may have caused and permit time to mitigate or settle these issues early in the project.

APPENDIX A

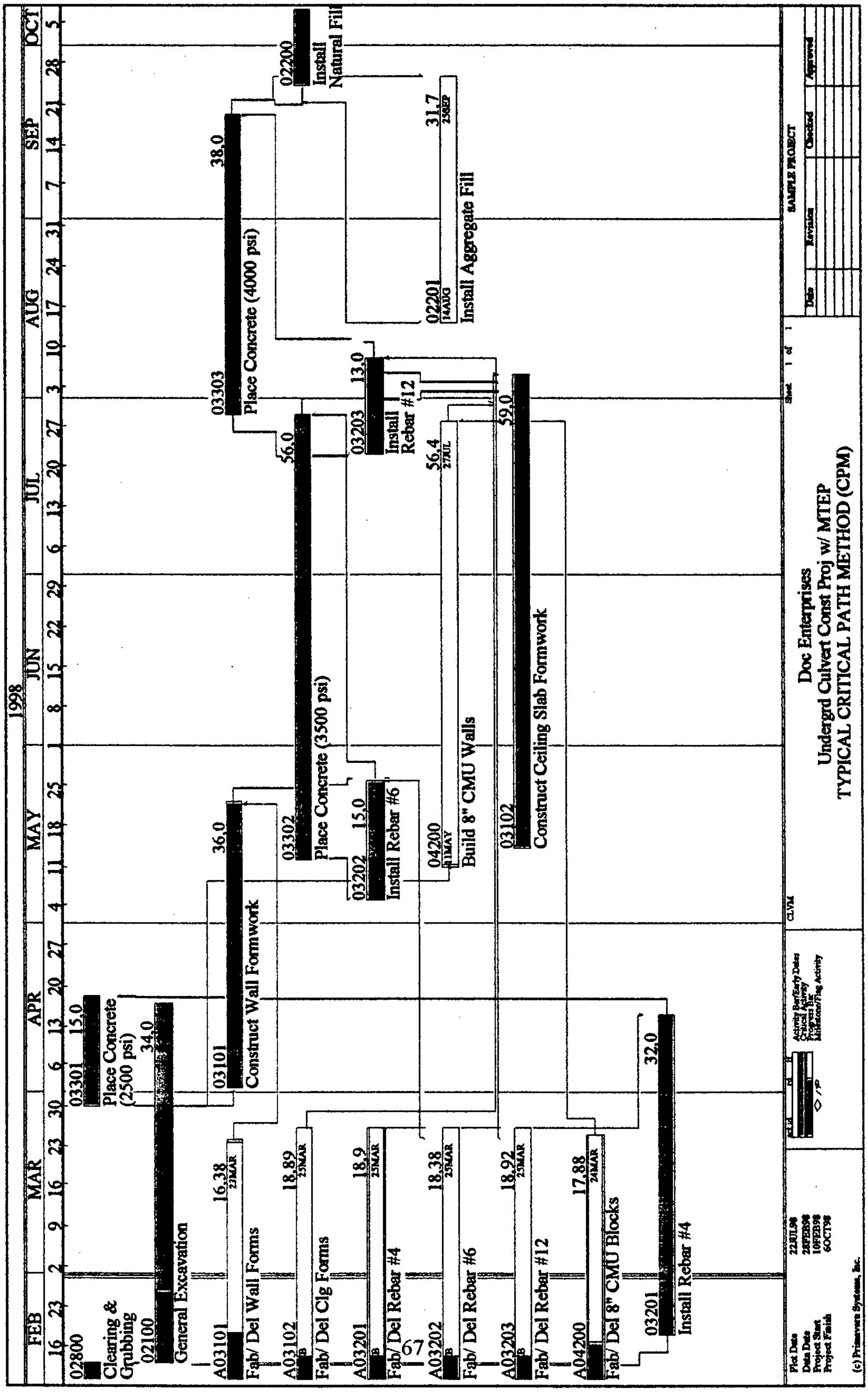
TYPICAL BAR CHART



ACTIVITY ID	BUDGET COST	EARLY START	EARLY FINISH	REM DUR	PCT
02800	3285	10FEB98A	12FEB98A	0	100
A03101	0	10FEB98A	23MAR98	16	20
A03102	0	10FEB98A	25MAR98	18	10
A03201	0	10FEB98A	25MAR98	18	10
A03202	0	10FEB98A	25MAR98	18	10
A03203	0	10FEB98A	25MAR98	18	10
A04200	0	10FEB98A	24MAR98	17	15
02100	906520	13FEB98A	16APR98	34	20
03201	344154	18FEB98A	14APR98	32	5
03301	189957	30MAR98	17APR98	15	0
03101	234911	2APR98	21MAY98	36	0
03202	145454	5MAY98	25MAY98	15	0
04200	515659	11MAY98	27JUL98	56	0
03302	510939	12MAY98	28JUL98	56	0
03102	342663	14MAY98	4AUG98	59	0
03203	125649	22JUL98	7AUG98	13	0
03303	453710	29JUL98	18SEP98	38	0
02201	1258971	14AUG98	25SEP98	31	0
02200	67914	24SEP98	6OCT98	9	0

APPENDIX B

TYPICAL CRITICAL PATH METHOD (CPM)



APPENDIX C

APPENDIX C

ACTIVITY SORTING CODES

PRIMAVERA PROJECT PLANNER

Date 22JUL98 -----ACTIVITY CODES DICTIONARY----- Page 1

N324 - ACF - COMPLETE CPM SCHEDULE (REV. 3)

Activity Codes:

CODE	VALUE	TITLE	SEQUENCE
CDA	CONST DISC AREAS		
	ACOU	ACCOUSTIC AND LINEAR CEILING SYSTEMS	
	ALOW	CONTRACT ALLOWANCE	
	ALUM	ALUMINUM DOORS AND WINDOWS	
	AWRD	AWARD FEE PROGRAM	
	BATH	BATHROOM PARTITIONS AND ACCESSORIES	
	BITU	BITUMINOUS CONCRETE PAVING	
	BOND	CONTRACTOR BOND	
	CARP	ROUGH CARPENTRY	
	CHNG	CHANGE ORDERS	
	CONC	CONCRETE	
	CONT	HVAC CONTROLS & INSTRUMENTATION	
	COOR	MEP COORDINATION	
	CSWK	METAL & WOOD CASEWORK	
	CURT	CURTAIN WALL SYSTEM	
	DOOR	DOORS	
	DRYW	DRYWALL PARTITIONS	
	DUMB	DUMBWAITERS	
	ELEC	ELECTRICAL	
	ELEV	ELEVATORS	
	EQPT	EQUIPMENT	
	ERTH	EARTHWORK	
	FIRE	FIRE PROTECTION SYSTEM	
	FLOR	FINISH FLOORING	
	FMWK	FORMWORK	
	FOOD	FOOD SERVICE EQUIPMENT	
	FRPF	SPRAY-ON FIREPROOFING	
	GENC	GENERAL CONDITIONS	
	HDWR		
	HVAC	HVAC SYSTEM	
	IRIG	IRRIGATION	
	LAND	LANDSCAPE	
	MECH	MECHANICAL SYSTEMS	
	METL	METAL PANELS AND ROOFS	
	MILL	FINISH CARPENTRY/MILLWORK	
	MISC	MISC EQUIPMENT	
	MMTL	MISCELLANEOUS METALS	
	MOCK	MOCK-UPS	
	MSRY	MASONRY	
	NAVY	OICC	
	PANT	PAINTING	
	PILE	FOUNDATIONS PILES	
	PLAS	PLASTER WALLS & CEILINGS SYSTEM	
	PLBG	PLUMBING	
	PNEU	PNEUMATIC TUBE SYSTEM	
	PREC	PRECAST	
	PVMT	PAVEMENT	
	REBA	CONCRETE REINFORCING	
	ROOF	ROOF	
	SEAL	SEALANTS	
	SIGN	SIGNAGE	
	SKYL	SKYLIGHTS	
	SPEC	SPECIALTIES	
	SSTL	STRUCTURAL STEEL	
	STER	STERILIZERS	
	SUMM	SUMMARY ACTIVITY	
	TABL	TESTING AND BALANCING	
	TILE	CERAMIC TILE	
	UTIL	UTILITIES	
	WNDW	WINDOWS	
	WTRP	WATERPROOFING	
AREA	BUILDING AREA		
	AREA		1
	BLDG	GENERAL BUILDING AREA	1
	1--A	1ST FLR - AREA A	2
	1--AA	1ST FLR - AREA Aa	2
	1--AB	1ST FLR - AREA Ab	2
	1--B	1ST FLR - AREA B	3
	1--BA	1ST FLR - AREA Ba	3

N324 - ACF - COMPLETE CPM SCHEDULE (REV. 3)

CODE	VALUE	TITLE	SEQUENCE
	1--BB	1ST FLR - AREA Bb	3
	1--C	1ST FLR - AREA C	4
	1--CA	IST FLR - AREA Ca	4
	1--CB	1ST FLR - AREA Cb	4
	1--D	1ST FLR - AREA D	5
	1--DA	1ST FLR - AREA Da	5
	1--DB	1ST FLR - AREA Db	5
	1--E	1ST FLR - AREA E	6
	1--F	1ST FLR - AREA F	7
	1I-A	1ST INTERSTITIAL FLR - AREA A	8
	1I-AA	1ST INTERSTITIAL FLR - AREA Aa	8
	1I-AB	1ST INTERSTITIAL FLR - AREA Ab	8
	1I-B	1ST INTERSTITIAL FLR - AREA B	9
	1I-BA	1ST INTERSTITIAL FLR - AREA Ba	9
	1I-BB	1ST INTERSTITIAL FLR - AREA Bb	9
	1I-C	1ST INTERSTITIAL FLR - AREA C	10
	1I-CA	1ST INTERSTITIAL FLR - AREA Ca	10
	1I-CB	1ST INTERSTITIAL FLR - AREA Cb	10
	1I-D	1ST INTERSTITIAL FLR - AREA D	11
	1I-DA	1ST INTERSTITIAL FLR - AREA Da	11
	1I-DB	IST INTERSTITIAL FLR - AREA Db	11
	1I-E	1ST INTERSTITIAL FLR - AREA E	12
	1I-F	1ST INTERSTITIAL FLR - AREA F	13
	2--A	2ND FLR - AREA A	14
	2--AA	2ND FLR - AREA Aa	14
	2--AB	2ND FLR - AREA Ab	14
	2--B	2ND FLR - AREA B	15
	2--BA	2ND FLR - AREA Ba	15
	2--BB	2ND FLR - AREA Bb	15
	2--C	2ND FLR - AREA C	16
	2--CA	2ND FLR - AREA Ca	16
	2--CB	2ND FLR - AREA Cb	16
	2--D	2ND FLR - AREA D	17
	2--DA	2ND FLR - AREA Da	17
	2--DB	2ND FLR - AREA Db	17
	2--E	2ND FLR - AREA E	18
	2--F	2ND FLR - AREA F	19
	2I-A	2ND INTERSTITIAL FLR - AREA A	20
	2I-AA	2ND INTERSTITIAL FLR - AREA Aa	20
	2I-AB	2ND INTERSTITIAL FLR - AREA Ab	20
	2I-B	2ND INTERSTITIAL FLR - AREA B	21
	2I-BA	2ND INTERSTITIAL FLR - AREA Ba	21
	2I-BB	2ND INTERSTITIAL FLR - AREA Bb	21
	2I-C	2ND INTERSTITIAL FLR - AREA C	22
	2I-CA	2ND INTERSTITIAL FLR - AREA Ca	22
	2I-CB	2ND INTERSTITIAL FLR - AREA Cb	22
	2I-D	2ND INTERSTITIAL FLR - AREA D	23
	2I-DA	2ND INTERSTITIAL FLR - AREA Da	23
	2I-DB	2ND INTERSTITIAL FLR - AREA Db	23
	2I-E	2ND INTERSTITIAL FLR - AREA E	24
	2I-F	2ND INTERSTITIAL FLR - AREA F	25
	3--A	3RD FLR - AREA A	26
	3--B	3RD FLR - AREA B	27
	3--C	3RD FLR - AREA C	28
	3--D	3RD FLR - AREA D	29
	3--E	3RD FLR - AREA E	30
	3--F	3RD FLR - AREA F	31
	3I-A	3RD INTERSTITIAL FLR - AREA A	32
	3I-B	3RD INTERSTITIAL FLR - AREA B	33
	3I-C	3RD INTERSTITIAL FLR - AREA C	34
	3I-D	3RD INTERSTITIAL FLR - AREA D	35
	3I-E	3RD INTERSTITIAL FLR - AREA E	36
	3I-F	3RD INTERSTITIAL FLR - AREA F	37
	4--A	4TH FLR - AREA A	38
	4--B	4TH FLR - AREA B	39
	4--C	4TH FLR - AREA C	40
	4--D	4TH FLR - AREA D	41
	4--E	4TH FLR - AREA E	42
	4--F	4TH FLR - AREA F	43
	5--A	5TH FLR - AREA A	44
	5--B	5TH FLR - AREA B	45
	5--C	5TH FLR - AREA C	46
	5--D	5TH FLR - AREA D	47

CODE	VALUE	TITLE	SEQUENCE
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	5--F	5TH FLR - AREA F	49
	6--A	6TH FLR - AREA A	51
	6--B	6TH FLR - AREA B	52
	6--C	6TH FLR - AREA C	53
	6--E	6TH FLR - AREA E	54
	6--F	6TH FLR - AREA F	55
	7--A	7-FLR - AREA A	56
	7--B	7-FLR - AREA B	56
	7--C	7-FLR - AREA C	57
	7--E	7-FLR - AREA E	58
	7--F	7-FLR - AREA F	59
	8--C	8-FLR - AREA C	60
	8--E	8-FLR - AREA E	61
	-	ACF BUILDING - ALL AREAS	62
	A	AREA A - ALL LEVELS	63
	B	AREA B - ALL LEVELS	64
	C	AREA C - ALL LEVELS	65
	D	AREA D - ALL LEVELS	66
	E	AREA E - ALL LEVELS	67
	F	AREA F - ALL LEVELS	68
	EL-A	EXTERIOR ELEVATION A	70
	EL-B	EXTERIOR ELEVATION B	71
	EL-C	EXTERIOR ELEVATION C	72
	EL-D	EXTERIOR ELEVATION D	73
	EL-E	EXTERIOR ELEVATION E	74
	EL-F	EXTERIOR ELEVATION F	75
	EL-G	EXTERIOR ELEVATION G	76
	EL-H	EXTERIOR ELEVATION H	77
	EL-I	EXTERIOR ELEVATION I	78
	EL-J	EXTERIOR ELEVATION J	79
	EL-K	EXTERIOR ELEVATION K	80
	EL-L	EXTERIOR ELEVATION L	81
	EL-M	EXTERIOR ELEVATION M	82
	EL-N	EXTERIOR ELEVATION N	83
	EL-P	EXTERIOR ELEVATION P	84
	EL-Q	EXTERIOR ELEVATION Q	85
	BRDG	BRIDGES TO GARA,CEP,&215	86
	CEP	CENTRAL ENERGY PLANT	
	GARA	EXISTING PARKING GARAGE	
	MER12	MECHANICAL ROOM # 12	
	MER13	MECHANICAL ROOM # 13	
	MER14	MECHANICAL ROOM # 14	
	MER15	MECHANICAL ROOM # 15	
	MER18	MECHANICAL ROOM # 18	
	MER21	MECHANICAL ROOM # 21	
	MER22	MECHANICAL ROOM # 22	
	MER23	MECHANICAL ROOM # 23	
	MER24	MECHANICAL ROOM # 24	
	MER25	MECHANICAL ROOM # 25	
	MER28	MECHANICAL ROOM # 28	
	MER32	MECHANICAL ROOM # 32	
	MER33	MECHANICAL ROOM # 33	
	MER36	MECHANICAL ROOM # 36	
	MER37	MECHANICAL ROOM # 37	
	MER52	MECHANICAL ROOM # 52	
	MER54	MECHANICAL ROOM # 54	
	MER55	MECHANICAL ROOM # 55	
	MER58	MECHANICAL ROOM # 58	
	MER63	MECHANICAL ROOM # 63	
	MERS	ELEVATORS MECHANICAL ROOMS	
	SITE	ACF - SITE	
FLOW	CONSTRUCT. FLOW		
	ACFF		
	FLO-1	FLOW NO. 1	
	FLO-2	FLOW NO. 2	
	FLO-3	FLOW NO. 3	
	FLO-4	FLOW NO. 4	
	FLO-5	FLOW NO. 5	

N324 - ACF - COMPLETE CPM SCHEDULE (REV. 3)

CODE	VALUE	TITLE	SEQUENCE
SECT	BUILDING SECTION		
	-	ACF - ALL BLDG SECTIONS	
	A	ACF - BLDG SECTION A (ALL LEVELS)	
	B	ACF - BLDG SECTION B (ALL LEVELS)	
	C	ACF - BLDG SECTION C (ALL LEVELS)	
	D	ACF - BLDG SECTION D (ALL LEVELS)	
	E	ACF - BLDG SECTION E (ALL LEVELS)	
	F	ACF - BLDG SECTION F (ALL LEVELS)	
CATG	ACTIV. CATEGORY		
	PROJ	GENERAL PROJECT ADMINISTRATION	1
	SUBM	SUBMITTAL & APPROVAL ACTIVITY	2
	FABR	FABRICATION & DELIVERY ACTIVITY	3
	WORK	WORK ACTIVITY	4
	COOR	MEP COORDINATION	5
	VECP	STRUCTURAL VALUE ENGINEERING	6
	EXEC	EXECUTIVE SUMMARY ACTIVITY	7
	SUMM	SUMMARY ACTIVITY	8
	AWRD	AWARD FEE PROGRAM	9
	PROP	CHANGE ORDER	10
PHAS	CONSTRCT. PHASE		
	GENE	GENERAL PROJECT ADMINISTRATION	1
	PROC	PROCUREMENT (SUBMITTALS, APPROVAL, FABRICATION)	2
	FNDTN	BUILDING FOUNDATIONS	3
	STRUT	BUILDING STRUCTURE	4
	EXTER	BUILDING EXTERIOR	5
	PERM	PERMANENT POWER	6
	ELEV	ELEVATORS & CASE CART SYSTEMS	7
	MERS	MECHANICAL ROOMS	8
	CEP	CENTRAL ENERGY PLANT	9
	SITE	SITEWORK	10
	INTER	BUILDING INTERIOR	11
	TEST	PUNCH LIST & SYSTEMS FINAL TESTING	12
	PARK	PARKING GARAGE ADDITION	13
	VY GE	GOVERNMENT WORK	14
RESP	TASK RESPONSIB.		
	PPIPE	PLUMBING PIPE SUB	1
	DUCT	DUCTWORK SUB	2
	MPIPE	MECHANICAL PIPING SUB	3
	MDGAS	MEDICAL GAS SUB	4
	PINSL	PLUMBING INSULATION SUB	5
	MINSL	MECHANICAL INSULATION SUB	6
	COMS	COMMUNICATION SYSTEMS SUB	7
	CONCS	CONCRETE SUB	8
	DIRTS	EXCAVATION & SITE PREP SUB	9
	DOORS	DOOR SUB	10
	ELECS	ELECTRICAL SUB	11
	FLOOR	FLOOR FINISH SUB	12
	LANDS	LANDSCAPING SUB	13
	MASNS	MASONRY SUB	14
	PAINT	PAINTING SUB	15
	STEEL	REBAR/ MISC STEEL SUB	16
	STSTL	STRUCTURAL STEEL SUB	17
	WALLS	DRYWALL & CEILING SUB	18
	WINDS	WINDOW SUB	19
	GENC	GENERAL CONTRACTOR	20
	GOVT	NAVY	21

Activity ID Codes:

Alias Codes:

APPENDIX D
MODIFICATION FRAGNET FORM

PROJECT NAME

CPM INPUT (FRAGNET) FOR CHANGE ORDER # ______

CPM UPDATE EFFECTED: ____________

EFFECTIVE DATE OF FRAGNET: ________

ACTIVITY INFORMATION					ACTIVITY CODE INFORMATION					AFFECTED CONTRACT WORK						IMPACT	
										PREDECESSOR			SUCCESSOR				
ACT ID	DUR (wkdys)	ACTIVITY DESCRIPTION	ES CONSTS	BUDGET AMT	CDA	RESP	AREA	FLOW	PHAS	ACT ID	RELAT TYPE	LAG	ACT ID	RELAT TYPE	LAG	CP AFFECTED	# OF DAYS

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APPENDIX E
APPENDIX E
DETAILED MODIFICATIONS

```
--------------------------------------------------------------------------------------
CENTEX BATESON CONSTRUCTION CO., INC          PRIMAVERA PROJECT PLANNER

REPORT DATE 22JUL98  RUN NO. 2130
         16:53
CHANGE ORDERS EXAMPLE

 ----- -----  ---- ---- - --- ----------  -------------------------------------------
  ACTIVITY    ORIG REM                               ACTIVITY DESCRIPTION
     ID       DUR  DUR     %
 ----- -----  ---- ---- - --- ----------  -------------------------------------------
  P00091        10    0    95             ZONE VALVE & ALARM PANELS (PCO0063) **

                               CODE       MGAS =BLDG =FLO-4=-     =PROP =INTER=MDGAS=

..C15484-1  *  200    0   100 PR SS     0 FAB MED GAS PIPING (INTERSTITIALS)
..C15484-2  *  200    0   100 PR SS     0 FAB MED GAS PIPING (ABOVE CEILING)
..C15484-3  *  200    0    97 PR SS     0 FAB MED GAS PIPING (IN WALLS)
..C15484-4  *  200   20    89 PR SS     0 FAB MED GAS TRIM DEVICES

..     76490    17   17     0 SU FF     0 R/I INWALL MED GAS  5-FL"C" *


  P00214         1    1    40             MODIFY DOOR ENTRANCE 120300 (PCO00053)

                               CODE       DOOR =1--D =FLO-1=D     =PROP =INTER=DOORS=

..     22110*    6    0   100 PR SS     0 FORM SLAB AREA 2 - A3

..     38490     5    5     0 SU FF     0 FRAME/PLASTR SOFF. EL-C, FLR 1-4


  P00319-1       1    1    60             MED GAS OUTLETS (PCO0118)

                               CODE       CHNG =     =     =ACFF =     =     =PROP =

..     58270*    3    0   100 PR SS     0 R/I ABV.CLG MED GAS 2-FL"Ab"*

..     58490*    8    0    90 SU FF     0 R/I INWALL MED GAS  2-FL"Ab"*


  P00408         3    0    90             MOVE DOOR IN ROOM 220325 (PCO0504)

                               CODE       DOOR =2--CA=FLO-2=B     =PROP =INTER=DOORS=

..     57510*   20    0   100 PR          GYPBRD/INSUL WALLS  2-FL"Aa"*

..     57514*   30    0   100 SU FF     0 T&B DRYWALL PART.   2-FL"Aa"
```

APPENDIX F
CPM MONTHLY OVERVIEW

20 June 96

ACF CPM MONTHLY OVERVIEW
PERIOD FROM 3 May 96 - 31 May 96
(FINAL CPM)

I. LOGIC CHANGES

1. No major logic changes this period.

II. CONCERNS:

* Manpower Resources. It does not appear that there is sufficient manpower resources to achieve 41 month CPM completion date. Several relationship changes from Finish to Start to Start to Start relationship will majorily affect CCI, Natkin, Retro, and F&M. From prior meetings, CCI, Natkin, and Retro have all indicate difficulty obtaining additional manpower resources.

* Energize Permanent Power acts. With only 13 months remaining to your 41 month target schedule, it would appear that the substations and ACF would have permanent power by now. According to the original CPM schedule, the late finish for the permanent power for the first substation (North) and the first Area (Area 1-Aa) should have been 8 Dec 95 and 4 Mar 96, respectively. Hence, according to this updated CPM schedule, you have not yet completed these areas. Hence, permanent power has fallen behind by more than 6 and 3 months, respectively.

III. PROBLEM AREAS

1. Various ductwork activities - $ WIP and TF for ductwork have fallen behind projections. Invoice of $445,247 was substantially lower than expected. Very few HANG DUCT acts were WIPed this period. Several critical path acts involve INST GRILLS/ DIFF, HANG DUCT, DALTs, AIR TABS and INSUL DUCT. Need to watch insulation activities for HVAC and PLBG. Retro has limited resources. As walls and ceiling construction is expedited, Retro may have problems keeping up. The 41 month schedule reveals a total float of -14 workdays. Last month the TF for the 41 month schedule was -12 workdays.
(Based on the 38 month schedule - Several acts would have a total float of -82 work days. Last period, total float for these acts was -80 workdays.)

2. Drywall acts - **CP Driver.** The pulse for all interior flow activities. Made up some progress this month with $842K WIP (highest invoice to date). Currently $2.29M behind original schedule $s. Drywall act delays have caused a ripple effect amongst several

interior flow and finish acts. Not sure other trades will be able to keep up with the sudden increase production pace of the drywall subcontractor. Drywall manpower has increased to an average of 52 people/ day.
(Based on the 38 month schedule - Several acts would have a total float of -83 work days. Last period, total float for these acts was -80 workdays.)

3. Electrical acts - **CP Driver.** Currently $5.36M behind the original late schedule. Based on Late schedule projections, acts may fall further behind over next month. At the current rate of monthly WIP $s, don't expect them to achieve projections unless other measures are taken. Most critical path acts involve CLG LIGHT FIX (Ceiling related, even though schedule doesn't accurately reveal it), R/I INWALL CNDT (wall related), R/I ABV CEIL WIRE (clg related). This has the potential to substantially effect the 41 month completion date. Manpower has increased slightly from 59 to 63 people. The 41 month schedule reveals a total float of -15 workdays. Last month the TF for the 41 month schedule was - 12 workdays
(Based on the 38 month schedule - Several acts would have a total float of -83 work days. Last period, total float for these acts was -80 workdays.)

4. Exterior Activities - $ WIP and TF for exterior related activities are behind projections. Invoice of $768K was slightly lower than expected. Currently $4.94M behind the original late schedule. No brick yet placed in areas E and F, areas just opened up for exterior. It appears that masonry several months behind mostly due to structure completing late. Masonry having difficulties obtaining more workers since the slow down a few months ago. Roof is still not progressing as quickly as expected. CPM forecast roof work this winter. Does not appear to be a good plan. C/B concurs and will insist that the CPM schedule will be changed to reflect the roof completing before this winter. The 41 month schedule reveals a total float of -4 workdays.

IV. OTHER ISSUES

1. Stats:

a) The schedule is further behind the "calculated" 41 month schedule. Last month behind approx. $7.04M. This month $7.34 behind. Invoice was $4.2M with $750K being FAB (materials). Extremely low invoice. CPM completion date of 22 Jul 97 was determined by altering several relationships from Finish to Start to Start to Start with a lag last period.

b) Time elapsed:
- CPM Completion Date - 67.1%
- Contract Term - 62.2%

ACF CPM SUMMARY

BASED OFF OF THE ORIGINALLY
APPROVED SCHEDULE

I. TOTAL FLOAT FOR WORK AND FAB ACTIVITIES

NOTES	CPM SCHEDULE	CPM DATA DATE	TOTAL FLOAT LESS THAN/EQUAL TO 0 DAYS	7 DAYS	14 DAYS	30 DAYS
	NFR0	1 Feb, 94	**0**	0	0	0
	NFR1	10 Aug, 94	**0**	8	592	1258
	NFR2	12 Sep, 94	**522**	832	1051	1807
	NFR3	10 Oct, 94	**590**	899	1234	1875
	NFR4	7 Nov, 94	**670**	948	1300	1891
	NFR5	5 Dec, 94	**714**	1177	1437	2193
*	NFR6	10 Jan, 95	**376**	618	1003	2051
	NFR7	6 Feb, 95	**417**	964	1292	2114
	NFR8	10 Mar, 95	**1041**	1298	1654	2434
*	NFR9	7 Apr, 95	**780**	1111	1447	2241
	NF10	8 May, 95	**1150**	1484	1851	2453
*	N111	9 Jun, 95	**1485**	1756	2068	2700
	N112	10 Jul, 95	**1719**	1980	2212	2866
*	N113	11 Aug, 95	**1333**	1619	1924	2535
*	N214	8 Sep, 95	**2007**	2271	2550	3085
	N215	6 Oct, 95	**2218**	2489	2721	3274
	N216	6 Nov, 95	**2309**	2588	2787	3268
	N217	4 Dec, 95	**2777**	3007	3194	3637
*	N218	6 Jan, 96	**2495**	2702	2953	3339
	N219	2 Feb, 96	**2989**	3159	3264	3612
	N220	1 Mar, 96	**3063**	3195	3361	3659
	N221	5 Apr, 96	**3402**	3527	3650	3914
*	N322	3 May, 96	**3018**	3256	3418	3796
	N323	31 May, 96	**3230**	3422	3568	3916
*	N324	28 Jun, 96	**3230**	3422	3568	3916
*	N325	2 Aug, 96	**3809**	3885	3979	4182

NOTES

* - Indicates major Logic Changes. See respective Monthly Overviews for details.
** - Logic change & Schedule TARGET DATE ONLY adjusted to reflect 41 month schedule !!!
@ - Indicates additional major logic revisions. See C/B letter dtd 1 Apr 96

II. DIAGNOSTIC DATA (As of 2 Aug 96)

* CONTRACT COMPLETION DATE: 31 OCT 97
* CENTEX BATESON'S ORIGINAL SCHEDULE COMPLETION DATE: 30 MAR 97
* C/B's 41 MONTH SCHEDULE COMPLETION DATE: 30 JUN 97 - In effect 8 Sep 95

*** WIP ($EARNED) = 68.44%**

*** WIP (TIME TO THE CCD) =66.76%**
*** WIP (TIME TO 41 MONTH COMPLETION) =73.55%**
*** WIP (TIME TO CPM's Compl date) =70.25%**

TOTAL AMOUNT OF ACTIVITIES IN THE SCHEDULE - 8396
% ACT ON THE ORIG SCHEDULE CRITICAL PATH (TF<=0 DAYS) - 45.37%
WORK ACTIVITIES IN PROGRESS - 1161
WORK ACTIVITIES STARTED THIS PERIOD - 131 + 39 = 170
WORK ACTIVITIES COMPLETED THIS PERIOD - 0 + 63 = 63

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ACF CPM SUMMARY

III. DAYS LOST FROM THE ORIGINAL CPM SCHEDULE COMPLETION DATE

	CPM				WORKDAYS LOST FRM ORIG CPM COMPL DATE								
	UPDATED	CPM	EARLY	CALCULATED			RESPONSIBLE PARTY			R. P. CUMULATIVE			
NOTES	SCHEDULE	DATA DATE	COMPL. DATE	COMPL. DATE	DAYS	CUM	KTR	GOVT	CONCUR	KTR	GOVT	CONCUR	
TF - 39	NFR0	1 Feb, 94	4 Feb, 97	31 Mar, 97	0	0	0	0	0	0	0	0	
TF - 9	NFR1	10 Aug, 94	18 Mar, 97	31 Mar, 97	0	0	0	0	0	0	0	0	
TF - -4	NFR2	12 Sep, 94	4 Apr, 97	4 Apr, 97	4	4	4	0	0	4	0	0	
TF - -7	NFR3	10 Oct, 94	9 Apr, 97	9 Apr, 97	3	7	3	0	0	7	0	0	
TF - -12	NFR4	7 Nov, 94	16 Apr, 97	16 Apr, 97	5	12	5	0	0	12	0	0	
TF - -18	NFR5	5 Dec, 94	23 Apr, 97	23 Apr, 97	6	18	6	0	0	18	0	0	
TF - -4	NFR6	10 Jan, 95	4 Apr, 97	4 Apr, 97	-14	4	-14	0	0	4	0	0	
TF - -5	NFR7	6 Feb, 95	7 Apr, 97	7 Apr, 97	1	5	1	0	0	5	0	0	
TF - -18	NFR8	10 Mar, 95	24 Apr, 97	24 Apr, 97	13	18	13	0	0	18	0	0	
TF - -15	NFR9	7 Apr, 95	21 Apr, 97	21 Apr, 97	-3	15	-3	0	0	15	0	0	
TF - -25	NF10	8 May, 95	5 May, 97	5 May, 97	10	25	10	0	0	25	0	0	
TF - -48	N111	9 Jun, 95	6 Jun, 97	6 Jun, 97	23	48	23	0	0	48	0	0	
TF - -42	N112	10 Jul, 95	28 May, 97	28 May, 97	-6	42	-6	0	0	42	0	0	
TF - -47	N113	11 Aug, 95	5 Jun, 97	5 Jun, 97	5	47	5	0	0	47	0	0	
TF - -63	N214	8 Sep, 95	25 Jun, 97	25 Jun, 97	16	63	16	0	0	63	0	0	
TF - -66	N215	6 Oct, 95	27 Jun, 97	27 Jun, 97	3	66	3	0	0	66	0	0	
TF - -58	N216	6 Nov, 95	17 Jun, 97	17 Jun, 97	-8	58	-8	0	0	58	0	0	
TF - -77	N217	4 Dec, 95	14 Jul, 97	14 Jul, 97	19	77	10	2	7	68	2	7	@
TF - -78	N218	6 Jan, 96	15 Jul, 97	15 Jul, 97	1	78	1	-9	0	78	0	0	#
TF - -85	N219	2 Feb, 96	24 Jul, 97	24 Jul, 97	7	85	7	0	0	85	0	0	
TF - -88	N220	1 Mar, 96	29 Jul, 97	29 Jul, 97	3	88	3	0	0	88	0	0	
TF - -113	N221	5 Apr, 96	1 Sep, 97	1 Sep, 97	25	113	25	0	0	113	0	0	
TF - -80	N322	3 May, 96	17 Jul, 97	17 Jul, 97	-33	80	-33	0	0	80	0	0	
TF - -83	N323	31 May, 96	22 Jul, 97	22 Jul, 97	3	83	3	0	0	83	0	0	
TF - -100	N324	28 Jun, 96	13 Aug, 97	13 Aug, 97	17	100	17	0	0	100	0	0	
TF - -123	N325	2 Aug, 96	15 Sep, 97	15 Sep, 97	23	123	23	0	0	123	0	0	

NOTES:

@ - Government delay due to RF Shielding requirement in area 1-Ca. Gov't plans to delete requirement via mod.
Next CP driver activity is Interior Lighting related activities at 7 days delay - Contractor responsiblity.
When Mod is issued, delay responsibility will be eliminated.

\# - MOD PCO-509 issued to delete RF Shielding from contract. Gov't delay resp is eliminated.

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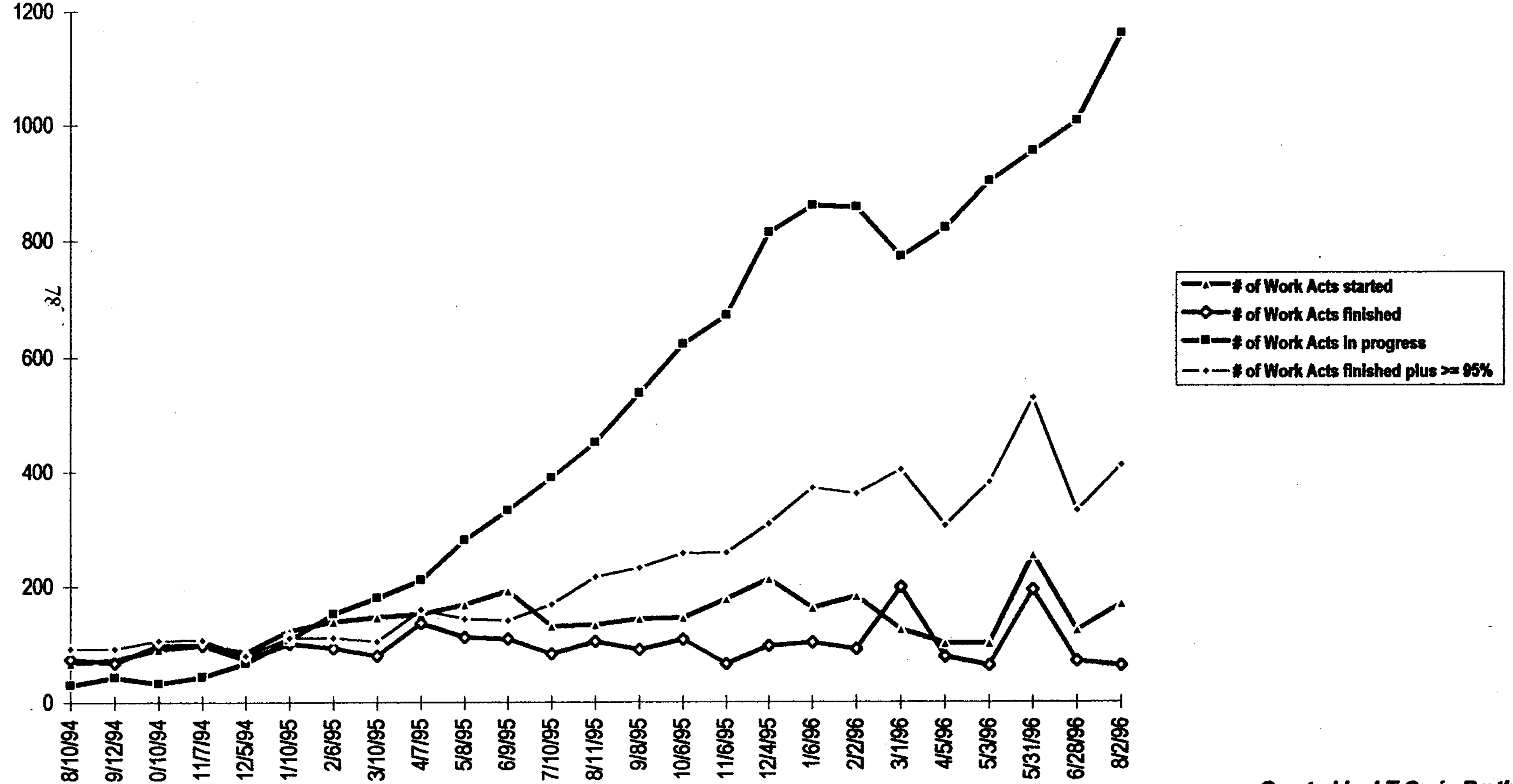
WORK ACTIVITIES STATUS



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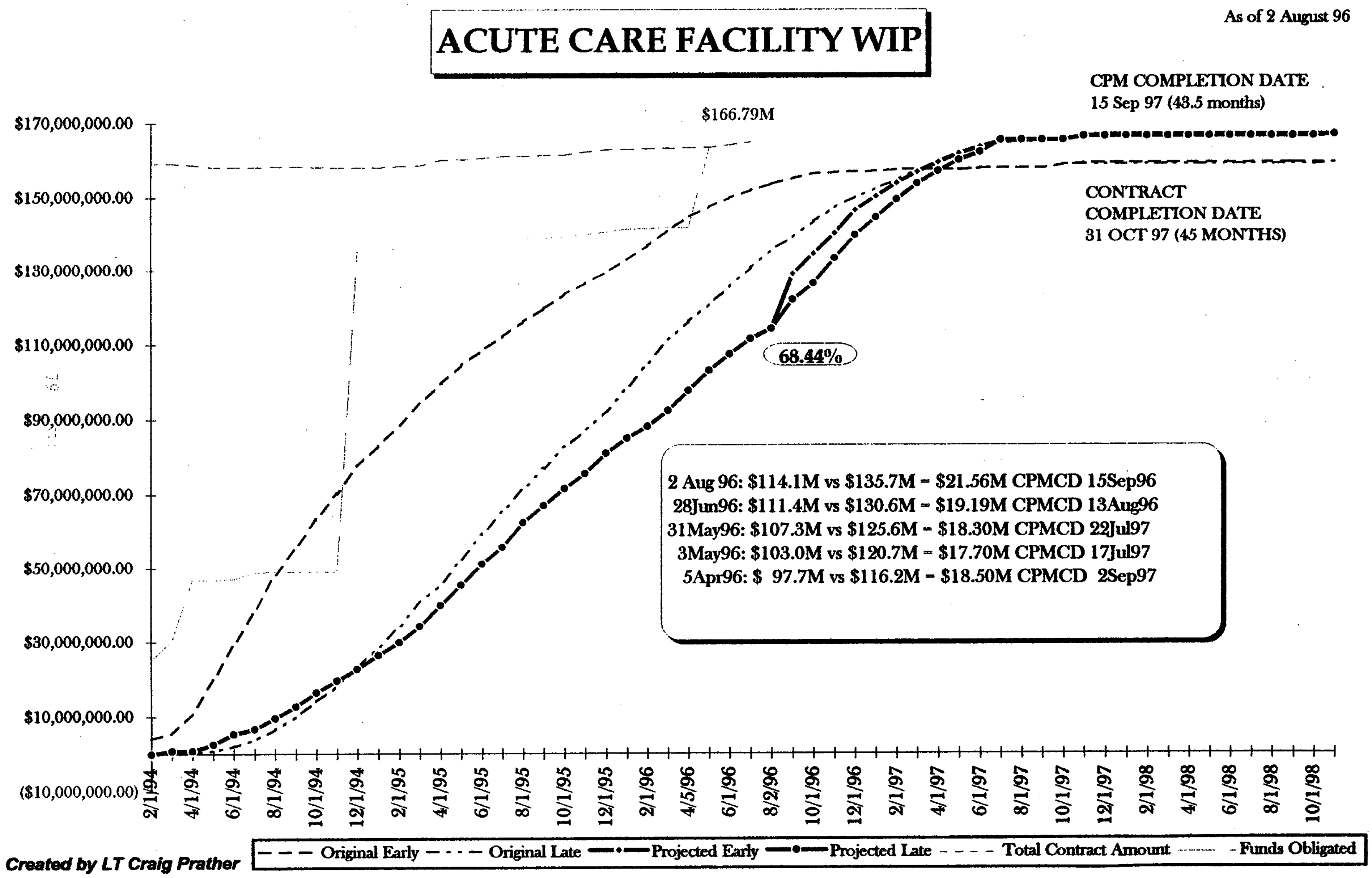
ACUTE CARE FACILITY WIP
As of 2 August 96
CPM COMPLETION DATE
15 Sep 97 (43.5 months)
CONTRACT
COMPLETION DATE
31 OCT 97 (45 MONTHS)
$166.79M
68.44%
2 Aug 96: $114.1M vs $135.7M = $21.56M CPMCD 15Sep96
28Jun96: $111.4M vs $130.6M = $19.19M CPMCD 13Aug96
31May96: $107.3M vs $125.6M = $18.30M CPMCD 22Jul97
3May96: $103.0M vs $120.7M = $17.70M CPMCD 17Jul97
5Apr96: $ 97.7M vs $116.2M = $18.50M CPMCD 2Sep97
$170,000,000.00
$150,000,000.00
$130,000,000.00
$110,000,000.00
$90,000,000.00
$70,000,000.00
$50,000,000.00
$30,000,000.00
$10,000,000.00
($10,000,000.00)
2/1/94
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12/1/94
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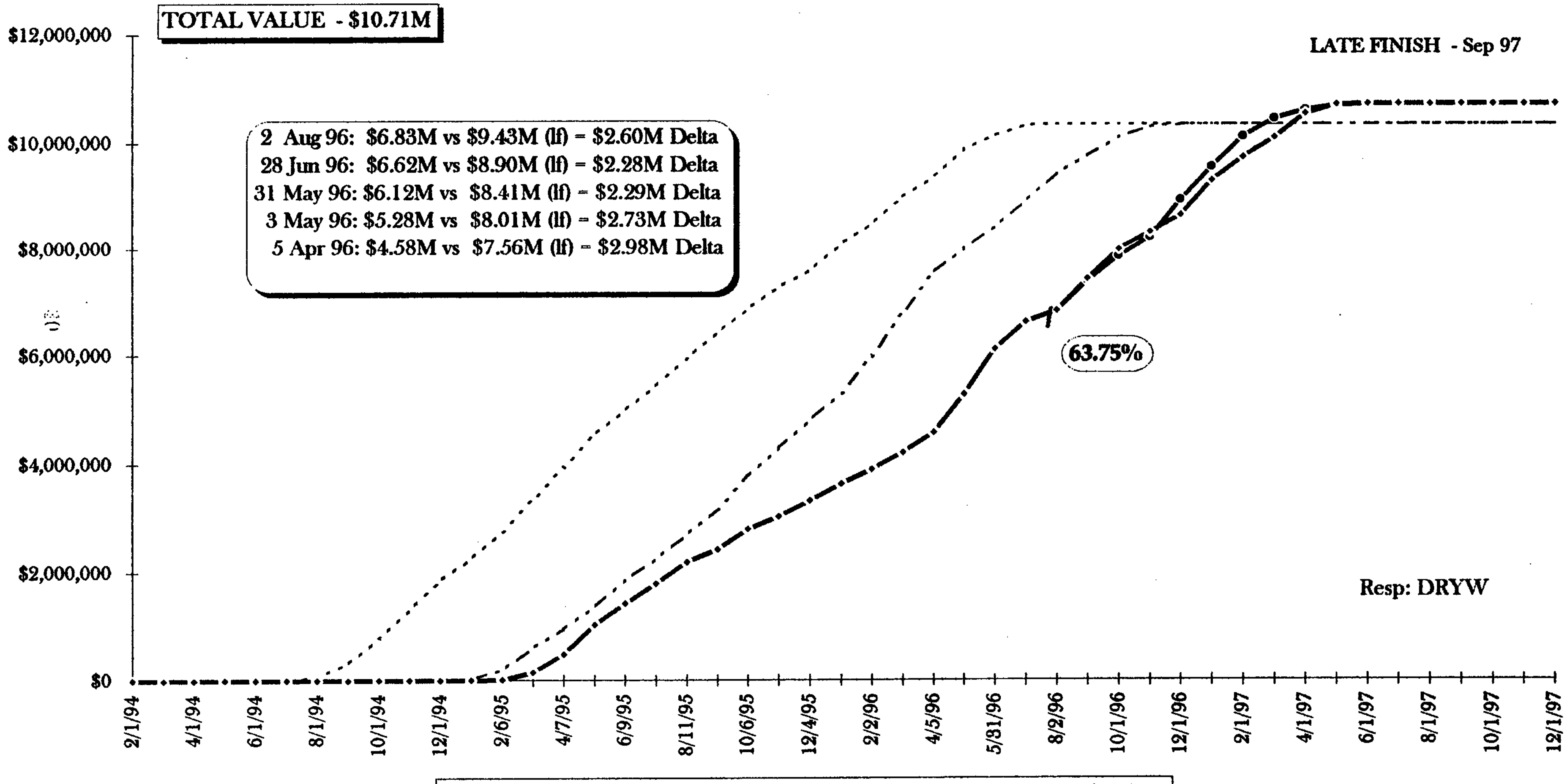
6/1/97
8/1/97
10/1/97
12/1/97
2/1/98
4/1/98
6/1/98
8/1/98
10/1/98
Original Early
Original Late
Projected Early
Projected Late
Total Contract Amount
Funds Obligated
Created by LT Craig Prather

As of 2 August 96

ACF DRYWALL ACTS WIP



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ACUTE CARE FACILITY

OICC PORTSMOUTH NAVAL HOSPITAL

MANPOWER ANALYSIS

CENTEX BATESON - COMPLETE PROJECT

	period	# of workdays	monthly manhours	ave manhours/ workday	monthly # of workers	ave workers/ workday
NFR2	11 AUG - 12 SEP 94	24	43304.00	1804.33	5262.00	219.25
NFR3	13 SEP - 10 OCT 94	22	42752.00	1943.27	5344.00	242.91
NFR4	11 OCT - 7 NOV 94	23	36655.00	1593.70	4636.00	201.57
NFR5	8 NOV - 5 DEC 94	24	43468.00	1811.17	5497.00	229.04
NFR6	6 DEC 94 - 10 JAN 95	25	55750.00	2230.00	6683.00	267.32
NFR7	11 JAN - 6 FEB 95	21	48423.00	2305.86	6419.00	305.67
NFR8	7 FEB - 10 MAR 95	26	58278.00	2241.46	7835.00	301.35
NFR9	11 MAR - 7 APR 95	22	62643.00	2847.41	8082.00	367.36
NF10	8 APR - 8 MAY 95	23	68262.00	2967.91	8472.00	368.35
N111	9 MAY - 10 JUN 95	24	79365.00	3306.88	9827.00	409.46
N112	11 JUN - 10 JUL 95	21	68978.00	3284.67	8631.00	411.00
N113	11 JUL - 11 AUG 95	25	86939.00	3477.56	10773.00	430.92
N214	12 AUG 95 - 8 SEP 95	20	65757.00	3287.85	8236.00	411.80
N215	09 SEP 95 - 06 OCT 95	21	73147.00	3483.19	9327.00	444.14
N216	07 OCT 95 - 06 NOV 95	21	66894.00	3185.43	9243.00	440.14
N217	07 NOV 95 - 04 DEC 95	19	61091.00	3215.32	7745.00	407.63
N218	05 DEC 95 - 6 JAN 96	20	66419.00	3320.95	8529.00	426.45
N219	7 JAN 96 - 2 FEB 96	20	60178.00	3008.90	7694.00	384.70
N220	3 FEB 96 - 1 MAR 96	21	61503.00	2928.71	7954.00	378.76
			1149806.00		146189.00	

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ACUTE CARE FACILITY

OICC PORTSMOUTH NAVAL HOSPITAL

MANPOWER ANALYSIS

CCI - Drywall Subcontractor

	period	# of workdays	monthly manhours	ave manhours/ workday	monthly # of workers	ave workers/ workday
NFR2	11 AUG - 12 SEP 94	0	0.00	0.00	0.00	0.00
NFR3	13 SEP - 10 OCT 94	0	0.00	0.00	0.00	0.00
NFR4	11 OCT - 7 NOV 94	0	0.00	0.00	0.00	0.00
NFR5	8 NOV - 5 DEC 94	0	0.00	0.00	0.00	0.00
NFR6	6 DEC 94 - 10 JAN 95	0	0.00	0.00	0.00	0.00
NFR7	11 JAN - 6 FEB 95	18	472.00	26.22	53.00	2.94
NFR8	7 FEB - 10 MAR 95	26	1940.00	74.62	244.00	9.38
NFR9	11 MAR - 7 APR 95	21	1924.00	91.62	263.00	12.52
NF10	8 APR - 8 MAY 95	23	2616.00	113.74	314.00	13.65
N111	9 MAY - 10 JUN 95	24	3472.00	144.67	434.00	18.08
N112	11 JUN - 10 JUL 95	20	2676.00	133.80	337.00	16.85
N113	11 JUL - 11 AUG 95	25	3282.00	131.28	411.00	16.44
N214	12 AUG 95 - 8 SEP 95	19	4048.00	213.05	555.00	29.21
N215	09 SEP 95 - 06 OCT 95	20	4778.00	238.90	608.00	30.40
N216	07 OCT 95 - 06 NOV 95	21	3528.00	168.00	441.00	21.00
N217	07NOV 95 - 04 DEC 95	17	2880.00	169.41	359.00	21.12
N218	05 DEC 95 - 6 JAN 96	20	4744.00	237.20	593.00	29.65
N219	07 JAN 96 - 2 FEB 96	20	4220.00	211.00	528.00	26.40
N220	3 FEB 96 - 1 MAR 96	21	5825.00	277.38	720.00	34.29
			46405.00		5860.00	

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8. U. S. Navy, Naval Facilities Engineering Command, Project Schedule Specifications, Section 01310, December 1994

9. Wickwire, Jon and Peter A. Warner, "Proving and Defending Time Impact Claims", Managing and Litigating the Complex Surety Case, American Bar Association, August 1996, Chapter 10.

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